10-1-35
Univ. of Mich. Lib.
Exch.

THE JOURNAL OF ENGINEERING EDUCATION

Published by the Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee.
R. L. Sackett, O. M. Leland, F. L. Bishop, Editor, University of Pittsburgh.
Published at Lancaster, Pa.

Entered as second-class matter at the Post Office at Lancaster, Pa., under the Act of March 3, 1870.

New Series Vol. XVIII, No. 4. DECEMBER, 1927 Subscription Price, $3.00 per year. Single Copies, 50 cents

TABLE OF CONTENTS.

A New Investigation under the Auspices of the Society. W. E. Wickenden..... 211
Education and Professional Societies. F. L. Bishop, Editor..... 213
Opinions of Professional Engineers Concerning Educational Policies and Practices..... 215
Notes on the Work of the Board and Staff. W. E. Wickenden..... 276
Cooperative Courses at the Massachusetts Institute of Technology. W. H. Timbie..... 280
Discussion: F. E. Ayer..... 293
W. E. Wickenden..... 301
Meeting of Division of Deans and Administrative Officers and Teachers of English, Maine Meeting..... 303
What the College Has Done for the Engineering Graduate. R. E. Doherty..... 334
A Brief History of the University of North Carolina. Geo. M. McKie..... 346
Report of Auditor, Carnegie Fund..... 350
Proposed Survey of Land-Grant College..... 352
Sections and Branches..... 355
North Carolina State College Branch..... 355
Ohio Section..... 355
College Notes:
University of Arizona..... i
Case School of Applied Science..... i

George Washington University ii
University of Hawaii iii
Iowa State College iii
Kansas State Agricultural College iv
University of Kansas vi
University of Minnesota vi
University of Missouri vii
Montana State College vii
North Carolina State College viii
Northeastern University viii
Oregon State Agricultural College viii
Pratt Institute ix
Syracuse University ix
North Texas Agricultural College x
University of Utah x
University of Wisconsin xi
Yale University xiv
New Members xvi

ii
iii
iii
iv
vi
vi
vii
vii
viii
viii
viii
ix
ix
x
x
xi
xiv
xvi

A NEW INVESTIGATION UNDER THE AUSPICES OF THE SOCIETY.

BY W. E. WICKENDEN,

Director of Investigation.

The Board of Investigation and Coordination and the Staff are gratified to announce that a special fund of $30,000 has been provided by certain educational institutions and the Carnegie Corporation for a parallel project to the investigation of engineering education recently conducted by the colleges. The new inquiry, as stated in the proposals which form the basis of the grant, is to be directed to the following ends:

1. To indicate the character and the extent of the need in the United States for a type of technological education having the following general characteristics.
   a. More advanced than the work of the secondary schools.
   b. Affording a general preparation for technical, supervisory and commercial services in industry, rather than specific training for skilled trades and occupations.
   c. Differing from the programs of the engineering colleges by being briefer, more intensive and more direct in method, less theoretical and more strictly technical in content and not leading to an academic degree.
   d. Principally full-time and cooperative day courses, but not excluding evening and extension courses organized into extended curricula.
2. To indicate the extent and character of the present facilities for giving education of this character and to appraise their effectiveness.
3. To indicate the means by which the needs may be met more adequately.

4. To indicate how institutions giving this type of technological education and the present engineering colleges may supplement each other so as to create a well-balanced system of higher technical education.
5. To indicate how the public educational authorities, the professional societies of engineers and industrial bodies may aid in establishing this type of education on a stable and adequate basis.

In defining the scope of the inquiry, attention was directed primarily to a type of education, rather than a type of institution. Many agencies now have some share in this form of education and the inquiry will seek to ascertain what their contributions are and how fully they meet the general need. It was also recognized that the field of specific training for crafts, trades and industrial processes, not commonly classed as forms of engineering activity, is one of great magnitude and importance, but that it warrants separate investigation under other auspices. A certain amount of overlap exists between that field and the area of the projected inquiry, and will be given due attention, but training for engineering activities is the end chiefly in view.

In line with the policy pursued in other investigations by the Society, a special advisory committee will be constituted, representing the interests most directly affected. Active cooperation will be sought from the technical institutes, extension schools, industries and public education authorities, as in the investigation by the engineering colleges. The Board of Investigation and Coordination will give the project general supervision, and the active measures of inquiry will be directed by the Society's staff. An extended report of the investigation will be disseminated in a form comparable to other publications of the Board, but having its own identity. The project is expected to extend through the year 1928.

Grateful acknowledgment is due to Mr. Frederic B. Pratt, President of the Board of Trustees of Pratt Institute of Brooklyn, at whose instance the fund has been provided for the project, and to the Carnegie Corporation for its generous participation.

EDUCATION AND PROFESSIONAL SOCIETIES.

BY F. L. BISHOP,

Secretary of the Society.

The basis of any profession is education. When a profession is young the education is obtained in general through the apprenticeship system. As the number in the profession increases and the pressure of young men to enter the profession becomes greater, schools are established for the training of the men to enter the profession. At the beginning these schools usually are merely the grouping of the apprentices under the men with whom they are at work in order to reduce the time which the professional men have been giving to instruction of apprentices. We see this clearly in the case of Law and Medicine in this country, where only a few years ago the most ordinary method of entering either of these professions was through serving a term in the lawyer's office or in the doctor's office. This was followed by examinations more or less perfunctory in character. Such a system naturally led to many abuses and finally schools were established until to-day it is almost impossible for a man to enter either of these professions except through an established school of law or medicine. The engineering profession is passing through the same development. From the report which is contained in this issue of the JOURNAL it is noted that while forty years ago less that a quarter of the members of these societies were graduates from college, to-day more than two thirds of those entering their membership are college graduates.

The engineering societies when they were established in this country adopted as a measure for admission an apprenticeship term and permitted graduation from college to be substituted for a certain number of years of apprenticeship. Thus, the engineering societies have measured their requirements for membership by the apprentice system and not by the educational qualifications. It would seem to the Editor that the

time is ripe to base the admission to engineering societies upon an educational basis; that is, graduation from an engineering college of recognized standing. For those who, for some reason, have been unable to attend college, a certain number of years of apprenticeship might be the equivalent to graduation from college. In other words base the admission to professional engineering societies upon a sound basis of professional education rather than upon an apprentice period.

The investigation which has been conducted through the cooperation of the engineering societies and published in this number of the JOURNAL contains much material which to the thoughtful would seem to lead to two conclusions:

1. That the engineering societies can now make education the fundamental basis for admission to the profession.

2. That the engineering societies shall interest themselves to a far greater extent in the problems of education which lead to the profession of engineering.

OPINIONS OF PROFESSIONAL ENGINEERS CONCERNING EDUCATIONAL POLICIES AND PRACTICES *

A Summary of Inquiries by
The American Society of Civil Engineers
The American Institute of Mining and Metallurgical Engineers
The American Society of Mechanical Engineers
The American Institute of Electrical Engineers
The American Institute of Chemical Engineers

Prefatory Note.—This Bulletin is arranged in two sections. The first, which comprises Parts I, II, and III, is based on all five inquiries and relates to engineering education in general. It includes a summary of general inferences and conclusions, a summary of opinions on a group of specific educational issues, and a summary of opinions concerning the extent and means of the influence of the engineering profession in engineering education. The second section comprises Parts IV to VIII inclusive and is devoted to the results of the inquiries which bear upon the several major divisions of engineering education, and to selected comments from each group of engineers.

* Bulletin Number 13 of the Investigation of Engineering Education. Copyright, 1927, by the Society for the Promotion of Engineering Education. Contents may be quoted with reference to the source.

PART I. INTRODUCTION AND SUMMARY OF GENERAL INFERENCES AND CONCLUSIONS

Purposes.—One of the major purposes of the general investigation of engineering education, conducted by the Society for the Promotion of Engineering Education from 1924 to 1927 inclusive, has been to prepare the way for a larger participation of the professional organizations of engineers in shaping the policies and practices of engineering education. As a definite step in that direction, the national engineering societies which correspond to the five major divisions of engineering education were invited to cooperate with the Board of Investigation and Coordination in conducting a group of special inquiries in order to ascertain the views of influential engineers on certain questions of present moment in engineering education and to gauge, both directly and by inference, the readiness of the profession as an organized body to exercise a share of responsibility for educational standards and processes. The principal inquiries were made through five questionnaires of the same general type, but with certain differences of detail to adapt each to the interests of the group addressed.

In addition to formal answers to definite questions, free comments of a more qualitative nature were sought under each of the heads and on the subject of engineering education in general. Many of these comments are of special value in revealing attitudes and shades of opinion. Certain data were also gathered from the personnel records of two of the participating societies in order to estimate the extent to which the engineering profession is dependent upon the colleges for the recruitment and training of its members.

Auspices.—Acknowledgment is due to the five professional societies which cooperated in the conduct of these inquiries, and individually to their national secretaries and the active representatives of the five committees through which cooperation was effected.

The American Society of Mechanical Engineers,
John Lyle Harrington, Chairman of Special Committee,
W. L. Durand, Secretary of Special Committee,
Calvin W. Rice, National Secretary.

The American Society of Civil Engineers,
Anson Marston, Chairman of Special Committee,
Harold M. Lewis, Secretary of Special Committee,
George T. Seabury, National Secretary.

The American Institute of Electrical Engineers,
Harold Pender, Chairman of Committee on Education,
Frederick L. Hutchinson, National Secretary.

The American Institute of Mining and Metallurgical Engineers,
William Kelly, Chairman of Special Committee,
W. B. Plank, Secretary of Special Committee,
H. Foster Bain, National Secretary.

The American Institute of Chemical Engineers,
H. C. Parmelee, Chairman of Educational Committee and National Secretary.

The inquiries were conducted in the order indicated above. The returns were compiled, analyzed and edited by the Staff of the general investigation. The material here presented is the result of the detailed compilation and complete statistical analysis of nearly eleven hundred returns, each dealing with a considerable number of items, and including both formal opinions and supplementary comments. The judgments on each point were weighed with careful regard to shades of opinion. In all the opinions summarized and the inferences drawn the editors have endeavored to set forth without bias the consensus or variety of judgments of the groups of engineers canvassed in the five inquiries. Graphical forms of presentation are employed throughout the Bulletin in place of statistical tables wherever practicable, with a view to greater vividness and to economy of space and attention.

Persons Consulted.—For the purposes of these studies the opinions of selected groups, representing the more influential men of the profession, were considered to be more significant than a random sampling covering all grades of professional standing and attainment. The lists to be canvassed were chosen with the advice of the committees and secretaries of the several societies in quotas roughly proportional to their respective memberships. The high calibre of the men consulted may be judged from the several summaries covering their education, responsibilities and types of activity to be found in Parts IV to VIII inclusive. Educators were included in relatively small proportions; since the opinions of teachers had already been canvassed in other inquiries, it was considered that the opinions of men of affairs should have the greater weight in this instance. The uniformly high proportions of replies received and the thoughtful quality of the opinions expressed indicate that the issues presented were given serious consideration. Taken as a whole, the summaries which follow are believed to be adequately representative of the mature judgment of the profession.

The numbers of persons canvassed and the returns received, by professional groups, are indicated below:

	Canvassed	Replied		Recorded	
Civil engineers (A. S. C. E.)	538	359	66.9%	327	61.3%
Mining engineers (A. I. M. E.)	306	177	57.8%	152	49.6%
Mechanical engineers (A. S. M. E.)	510	257	50.4%	239	46.9%
Electrical engineers (A. I. E. E.)	515	325	63.1%	271	52.6%
Chemical engineers (A. I. Ch. E.)	100	70	70.0%	69	69.0%
Total	1,969	1,188	60.3%	1,058	53.7%

The differences between the number of replies received and replies recorded are due in part to late returns and in part to the fact that some returns were in forms which did not admit of statistical compilation.

Issues Considered.—The specific questions concerning educational requirements and practices which were dealt with by questionnaires, fall under eight heads:

1. The fundamental elements which should be included in the education of all engineers.

2. The degree of differentiation between the programs of studies in the major divisions of engineering.

3. The extent and character of specialization within the major divisions of engineering.

4. The fundamental basis of differentiation of curricula; whether to accord with the major technical divisions of engineering, as at present, or with functional types of engineering activity.

5. The extent to which training in administration and management should be introduced into undergraduate curricula.

6. Training in economics and the economic aspects of engineering as an element in engineering programs.

7. The value and use of modern foreign languages.

8. The nature and extent of instruction in shop practice and in surveying.

The second group of questions dealt with matters of broad policy rather than questions of educational practice and was concerned specifically with the issue concerning the influence of the profession, through the national societies, upon engineering education, and the means to be employed to that end.

General Inferences and Conclusions

The Attitude of the Profession toward Education.—The engineering profession in America has never formulated a policy concerning the recruitment and training of its future members. Its guiding traditions, largely inherited from British sources, have been those of an open profession entered through a novitiate of practical experience, to which formal scientific training is a desirable but optional auxiliary. While these traditions are firmly maintained in principle, in reality they have been largely reshaped by changing conditions. Forty years ago less than a quarter of the members of national engineering societies were college graduates; to-day more than two-thirds of those entering their membership hold college degrees and more than four-fifths have had a substantial amount

of college training. The profession at large has accepted these changes passively. Probably it has not yet attained to the stage of unity and self-consciousness where it might attempt a formal shaping of educational policy. For the present it seems that its policy must be implicit, to be inferred from the general state of opinion.

Provisional Statement of Principles.—The data of these studies, more than any other body of material yet gathered, reduce the attitudes of the profession at large to an orderly basis for a provisional statement of educational policy. For the sake of simplicity and order, the broader inferences supported by these data are set forth as a series of propositions, with modifying comments:

a. Engineering is an open profession, accessible to both self-educated men and men of formal scientific culture. College training has become the normal first step to professional standing, but engineering education can not be reduced to a scholastic process alone. Experience in subordinate capacities under the direction and criticism of qualified practitioners is an indispensable part of the training of engineers.

b. Engineering is a broad function in social economy with varied types and grades of responsibility. Its personnel includes a well marked professional nucleus, with which are closely associated auxiliary and subordinate groups forming a natural vestibule to professional status and constituting a considerable proportion of the whole. To accord with this diversity, engineering education should include a variety of types and institutions ranging in character from the vocational to the professional. No single procrustean program, as in medical or dental education, can meet these varied needs.

While no explicit opinion was asked concerning the proper length of engineering college training, the replies tacitly accept the four-year undergraduate program as a norm for the great body of students; the need of many students for shorter and more intensive vocational curricula is pointed out in several comments; many specifically advise post-graduate work as the proper place for specialization; a moderate number

strongly recommend an academic college course as a desirable prelude to engineering study; and a few urge that a pre-engineering program of this type should be required in all cases.

c. Engineering is concerned with technological, economic and administrative problems; it has an immensely ramified scheme of individual specialization along both technical and functional lines and is further subdivided by grades of responsibility. It is impracticable to reproduce this complex pattern in a workable scheme of formal education, nor can students make valid choices among the many fields of specialization. The schools should concern themselves with underlying principles; principles are best taught in connection with their applications; technical subjects proper should serve as media for teaching principles and the characteristic engineering methods of thought and analysis, rather than attempt to prepare for specific types of practice.

d. Engineers as a body hold to a highly realistic educational philosophy. In their judgment formal teaching in advance of responsible experience should be limited largely to the underlying principles of engineering, its methods of analysis, its verbal, graphical and symbolic language processes, and its setting in contemporary civilization. They deem it wise to bring instruction largely within the range of the student's personal experience and observation as extended by laboratory processes. They deem it impossible to reproduce engineering problems as a whole, with their inseparable economic and administrative complications, in the artificially simplified setting of a school. Professional preparation may be begun in a school, but must be completed in practice.

e. The principal curricula of the engineering colleges should be differentiated from each other to a moderate degree only, sufficient to assure concentration on a logically related core of subject matter and to bring the student's efforts to a focus in one of the major engineering fields. In general actual specialization should be postponed to the years after graduation, and be undertaken either in the graduate school or in connection with introductory experience.

f. The program of the engineering colleges should be built up on broad lines from humanistic, scientific and technological materials of a basic character. A self-contained program which may be entered direct from secondary schools should be provided for the majority under definite engineering auspices, but encouragement should be given to students who voluntarily undertake to extend the range of humanistic studies in a college of arts before entering upon the study of engineering. A substantial core of English and economics, of mathematical and physical sciences, and of subjects which develop the scientific bases of engineering technology should form the common foundation of all undergraduate curricula.

g. Relatively few institutions should undertake to provide special training in specific fields of engineering practice, and this training should be largely in post-graduate courses. There should be considerable specialization among institutions at this stage, according to advantages of personnel, environment and equipment.

h. The economic aspects of engineering, as well as its technological aspects, deserve considerable emphasis in all engineering subjects. Engineering students should be given some introduction to the problems of administration and management, but no attempt should be made to give specific training for executive positions.

i. The quality of engineering education is determined primarily by the qualifications and effectiveness of teachers and the preparation and aptitude of students, rather than by curricula and equipment. Teachers should have both scholarly preparation and professional experience and should be in active touch with engineering practice. As far as practicable students should be selected for aptitude as well as scholastic attainment.

j. The engineering profession, through its national societies, should share in responsibility for shaping the programs and standards of engineering education. There is a substantial plurality of opinion in favor of giving formal recognition, in admissions to membership and the support of student

branches, to institutions which meet or exceed reasonable minimum standards in their requirements for admission and graduation and in the qualifications of their teaching staffs.

PART II. EDUCATIONAL REQUIREMENTS AND PRACTICES

A. Fundamental Elements to be Included in the Training of All Engineers

The first question of each questionnaire was substantially the same:

"What subjects in addition to Mathematics, Physics, Chemistry, Drawing and English should be included in all curricula in the major divisions of engineering (Civil, Mining, Mechanical, etc.)?"

To facilitate answers, each questionnaire form included a list of the usual subjects and of others frequently proposed as desirable additions or substitutes. The lists were not identical in every case, but were quite similar in their essential particulars. Spaces for checking selections were provided, as well as blank lines on which additional recommendations could be entered. The returns from the five groups are shown graphically in Fig. 1. The judgments of the several groups are not entirely free from certain characteristic biases. For example, civil engineers hold surveying in high esteem for all students and give a low rating to shopwork; while chemical engineers give surveying a very low rating and exceed other groups in their esteem for foreign language. Taken in combination, however, the rankings given the various subjects stand as a fairly decisive verdict on the much mooted question of fundamentals.

It is of interest to compare the rankings of the fundamental subjects by these groups, in which practitioners largely predominate, with the rankings made by a group of more than five hundred engineering professors, as shown in Fig. 2.[1] There is a striking conformity in the majority opinions of

[1] See Bulletin No. 9 of this series, p. 11.

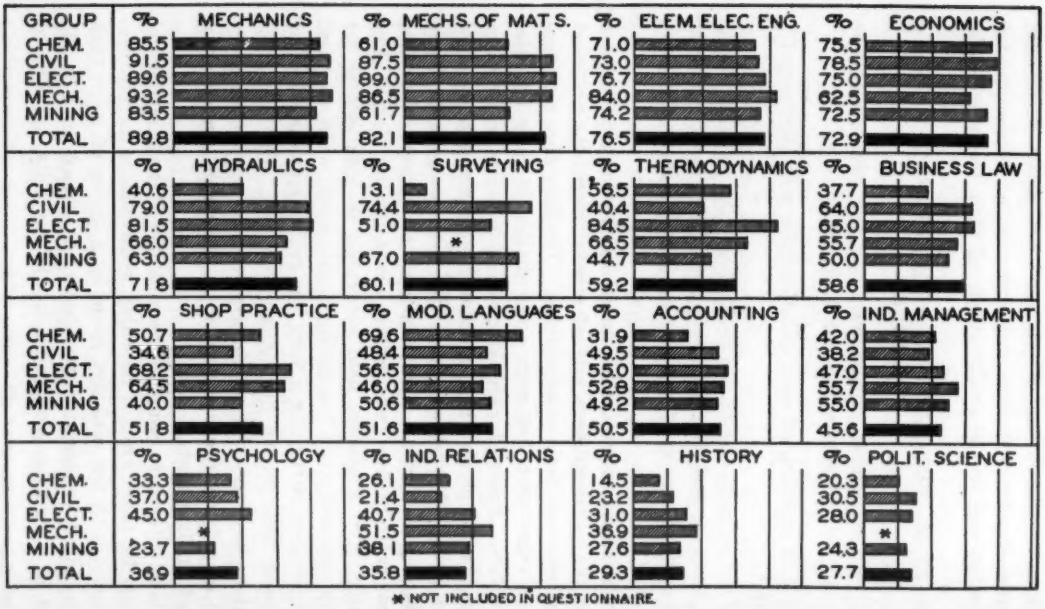
GROUP
% MECHANICS
% MECHS. OF MAT'S.
% ELEM. ELEC. ENG.
% ECONOMICS
CHEM. 85.5 61.0 71.0 75.5
CIVIL 91.5 87.5 73.0 78.5
ELECT. 89.6 89.0 76.7 75.0
MECH. 93.2 86.5 84.0 62.5
MINING 83.5 61.7 74.2 72.5
TOTAL 89.8 82.1 76.5 72.9
% HYDRAULICS
% SURVEYING
% THERMODYNAMICS
% BUSINESS LAW
CHEM. 40.6 13.1 56.5 37.7
CIVIL 79.0 74.4 40.4 64.0
ELECT. 81.5 51.0 84.5 65.0
MECH. 66.0 * 66.5 55.7
MINING 63.0 67.0 44.7 50.0
TOTAL 71.8 60.1 59.2 58.6
% SHOP PRACTICE
% MOD. LANGUAGES
% ACCOUNTING
% IND. MANAGEMENT
CHEM. 50.7 69.6 31.9 42.0
CIVIL 34.6 48.4 49.5 38.2
ELECT. 68.2 56.5 55.0 47.0
MECH. 64.5 46.0 52.8 55.7
MINING 40.0 50.6 49.2 55.0
TOTAL 51.8 51.6 50.5 45.6
% PSYCHOLOGY
% IND. RELATIONS
% HISTORY
% POLIT. SCIENCE
CHEM. 33.3 26.1 14.5 20.3
CIVIL 37.0 21.4 23.2 30.5
ELECT. 45.0 40.7 31.0 28.0
MECH. * 51.5 36.9 *
MINING 23.7 38.1 27.6 24.3
TOTAL 36.9 35.8 29.3 27.7
* NOT INCLUDED IN QUESTIONNAIRE.

FIG. 1. Subjects to be included in all engineering curricula, in addition to Mathematics, Physics, Chemistry, Drawing, and English; the percentages of the several groups of engineers who recommend each subject are indicated.

the two groups. The engineers consistently favor business and societal subjects more highly than the teachers, but the teachers are probably more restrained by knowledge of the time limitations of the college program in recommending additional subjects for inclusion.

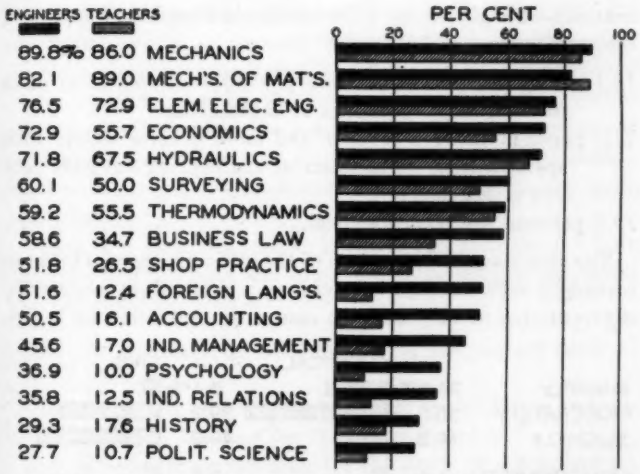

FIG. 2. Percentages of professional engineers who recommend basic subjects "for inclusion in all engineering curricula," and of engineering teachers who consider these subjects "of primary importance."

The subjects on which both groups are strongly agreed appear to embody a solid and coherent foundation for an education in any field of subsequent specialization. When the rankings of the subjects are compared with present curricula, the most striking contrast is between the high ranking given to economics and the relatively small provision for this type of instruction in many engineering curricula. This discrepancy is doubtless due in part to a lag in the adjustment of curricula to new conditions and emphases in the work of the profession, but it appears to be due in larger measure to the difficulty which many institutions experience in obtaining a treatment of the subject which is realistic and significant to engineering students.

B. Differentiation of Curricula in Major Divisions of Engineering

Each group was asked to indicate a preference as to the degree to which the curriculum in its own branch of engineering should be differentiated from those in the other major branches of engineering. The mechanical engineers expressed their preference as follows:

13.3 per cent favor a course *sharply differentiated* from those in other major branches of engineering,

71.0 per cent favor a *broader and more general course* with specialization in mechanical engineering subjects only to a minor degree,

15.7 per cent are non-committal.

The choice suggested to each of the other groups was between a *sharply differentiated* curriculum, a curriculum *moderately differentiated* or only so as to assure concentration on a logi-

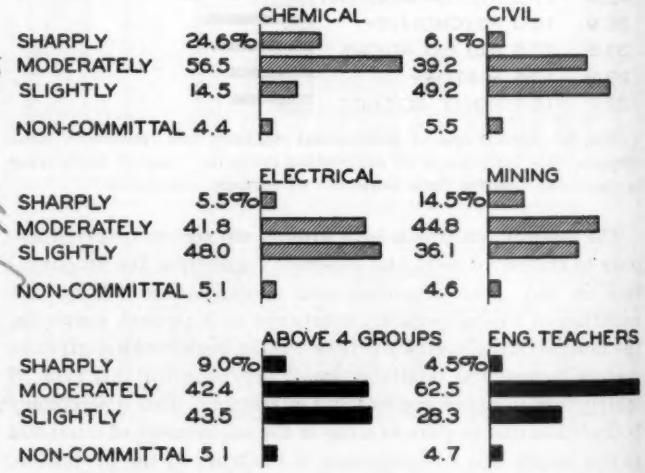

Fig. 3. Degree of differentiation between the principal engineering curricula recommended by groups of engineers and of engineering teachers.

cally related core of subject matter, and one *slightly differentiated* so as to give a broad and general engineering training. The judgments of the four groups are summed up graphically in Fig. 3, with the opinions previously expressed by more than five hundred engineering teachers [2] added for comparison.

Many of the engineers add comments to the effect that the curriculum should be devoted to fundamentals chiefly; a considerable number suggest that the last year be differentiated and an equal number advise that the student should specialize only after college or in the graduate school; others point out the inability of the average student to choose wisely; while a small minority set down a desire for more specialization quite pointedly.

There is a close agreement between the attitudes of both engineers and teachers, and those of a large body of graduates who are also on record:

20.6 per cent favor broad training for the general needs of industry,

67.5 per cent favor broad training for the majority and specialized training for those who desire it,

11.9 per cent favor training for the needs of specialized divisions of engineering practice.

C. Specialization Within the Major Branches of Engineering

The problem of specialization was presented to the several groups by questions of somewhat different form. The replies are summarized in detail in Parts IV to VIII inclusive. In general only a minority approve of complete, distinct curricula in the principal subdivisions of the five major branches. A larger number favor group options in these subdivisions in the last undergraduate year, and many indicate that all such specialization should be deferred until after graduation.

[2] See Bulletin No. 9 of this series, p. 3.

[3] See Bulletin No. 3 of this series, p. 14.

The replies to one question which had the same form in all the questionnaires may serve to indicate the general verdict on specialization. This question was:

"Should the instruction in the specific engineering subjects aim to prepare men for particular fields of work, or should they serve primarily as means of teaching fundamental scientific principles and engineering methods of thought and work?"

The replies of the five groups are summarized below:

	To Teach Engineering Principles and Methods	To Prepare for Particular Fields of Work	Approximate Ratio
Chemical engineers	92.8%	4.3%	22 : 1
Civil engineers	87.1	5.2	17 : 1
Electrical engineers	88.2	6.3	14 : 1
Mechanical engineers	68.7	12.6	5 : 1
Mining engineers	65.7	21.7	3 : 1

While all five groups are agreed in principle, it would seem that the mining engineers in particular, and the mechanical engineers to a lesser degree, attach relatively higher importance than other groups to the direct technical training afforded by the specific engineering subjects.

D. Functional vs. Technical Divisions of Engineering Curricula

The original separation of engineering into military and civilian branches was essentially functional. Through evolution the civilian arm of the profession was subdivided progressively into the technical branches now known as civil, mining, metallurgical, mechanical, electrical, chemical, and the like, according to the type of scientific content and technical arts employed. In recent years the development of large-scale industrial organization has tended to lessen the emphasis on the technical divisions of engineering and to bring into prominence a new cleavage of functional activities under such heads as engineering research, design, construction, operation, management, and sales.

The basic plan of organization of engineering curricula has been technical for the last sixty years and more. A tendency has appeared in the past few years to add a new type of curriculum which stresses the managerial and commercial functions of engineering. Quite recently Prof. Edward Bennett has challenged the basic technical plan of educational organization with vigor and has proposed a sweeping reorganization along functional lines.[4] He holds that a regrouping of curricula along functional lines would be in closer accord with the differing abilities and tastes of students and with the actual types of engineering activity. The essential features

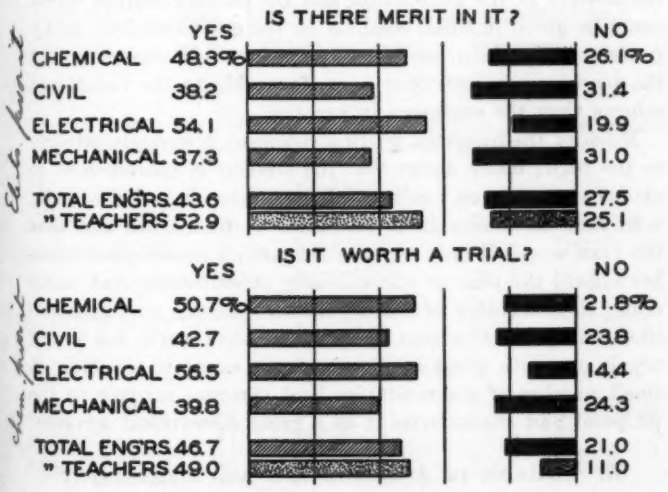

FIG. 4. Opinions of groups of engineers and engineering teachers concerning the proposal for a functional scheme of engineering curricula.

of his proposal are two-fold: One is the provision of two types of treatment of the fundamental subjects of the early years, profoundly technical and moderately technical; the second is the provision in the later years of more extended and rigorous

[4] See JOURNAL OF ENGINEERING EDUCATION, June, 1924.

treatment of engineering subjects for the groups with more profound preparation and of less extended technical treatment with a broader handling of non-technical features of these subjects for other groups.

The several groups of engineers consulted, with the exception of the mining engineers, were asked to indicate whether or not in their judgment the proposed scheme of functional curricula *has merit* and whether or not it is *worthy of an experimental trial* in one or more institutions. The verdict as a whole is inconclusive, more favorable than adverse, though barely half recommend a trial of the plan. In consequence of the novelty of the proposition and the sketchy outline which could be given in small compass on the questionnaires, many preferred to remain non-committal. It will be observed that the teachers are somewhat more favorable to the functional scheme than the engineers in practice.

Much of the informal, written comment is strongly adverse to the plan; many assert that the student is incompetent to choose a program on functional lines; others, in a similar vein, hold that the choice involved would be premature and that the plan would fit only experienced men; a considerable number regard the plan as educationally objectionable and many doubt the feasibility of classifying the students on functional lines; many consider that the plan has some merit, but would try it out with great caution and not carry it too far. A small number of commentators lend vigorous support to the proposal and characterize it as a great educational advance.

E. Training in Administration and Management

As indicated in the foregoing section there is widespread discussion of the training to be given to engineering students in functional activities. There is especially active discussion of the extent to which instruction in administration and management should be introduced into undergraduate engineering curricula.

"Should specific training of this character be given in college? If so, should it be given to all, to many or to few stu-

dents of engineering, and should it receive major or minor emphasis in the curriculum?"

These issues were put to the mechanical engineers in a fairly general form, as described in Part VII, but in the later questionnaires sent to the other four groups these questions were presented explicitly and the opportunity given to express a choice between three or four methods of meeting the problem.

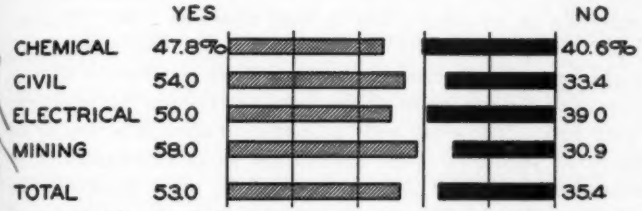

FIG. 5. Replies of groups of engineers to question, "Should specific training be given in administration and management?"

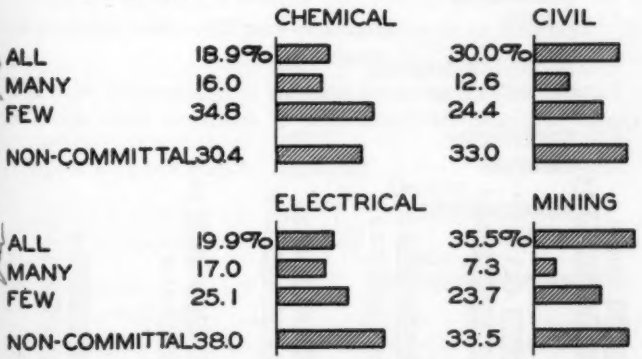

FIG. 6. Replies of groups of engineers to question, "Should specific training in administration and management be given to all, many, or few students?"

While the majority opinion clearly favors some specific attention to administration and management in the curriculum, to be available to the great majority of students, it also clearly favors keeping this type of instruction on a secondary plane

of importance. The spontaneous comments entered under these questions are of particular interest. The opinions that experience affords the only real training, that administrators are marked by inborn traits and must be discovered by natural selection, that attempts to teach such matters in college are premature and detract from important essentials, and that these subjects are not soundly teachable, are stated with marked emphasis. Sixteen voice their protests against special curricula in administration in such terms as "fad," "humbug," "waste," "folly" and "bunk"; on the other hand eight urge the provision of a distinct curriculum in administration, though more favor such instruction as graduate work only. The great body of moderate opinion is clearly in favor of including some instruction in administration and management in the regular curriculum, as a secondary or elective subject, with the aim of presenting the problems of management and not that of attempting to train executives.

F. Training in Economics and the Economic Aspects of Engineering

In view of the universal concern of engineering with economic problems, all five groups of engineers were asked to

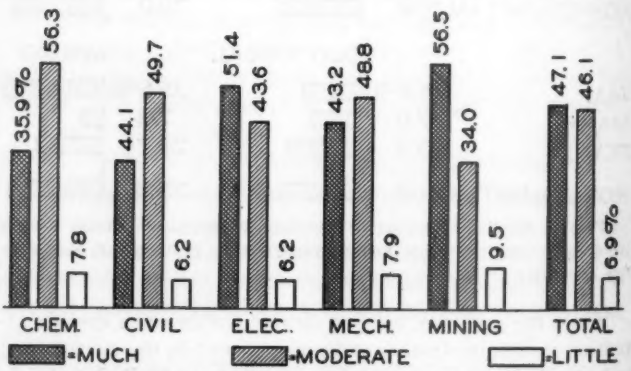

Fig. 7. Emphasis to be given to economics and to economic aspects of engineering in curricula and subject matter, as indicated by five groups of engineers.

indicate whether *much, moderate* or *little emphasis* should be given in the curricula and subject matter to economics and the economic aspects of engineering. The replies are highly consistent in placing the emphasis in the range from *moderate* to *much*.

All the groups were asked to indicate *whether or not they had found engineering graduates as well prepared to deal with the economic problems of engineering as with its technical aspects.* The mechanical engineers were asked this question with respect to graduates in general, but the question was divided in the subsequent inquiries so as to apply separately to graduates of less than five years' standing and those of five years' or more, in view of the frequent comment to the effect that ability of this type comes with maturity. The judgments expressed are strikingly consistent and point to a serious defi-

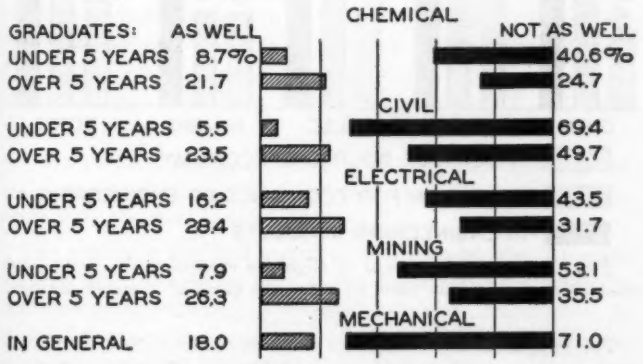

FIG. 8. Replies of groups of engineers to question, "Are engineering graduates as well prepared to deal with the economic problems of engineering as with its technical aspects?"

ciency on the economic side which is only partially overcome through the training and experience gained during the early years after graduation.

In pointing out the means to be taken to better this condition the majority of each group favor greater emphasis on the

economic aspects of engineering in the engineering subjects proper; a substantial minority favor one or more subjects in the curriculum given by a special division concerned with the economics of engineering; while a somewhat smaller group comprising less than one-quarter of the whole favor additional work under a department of general economics.

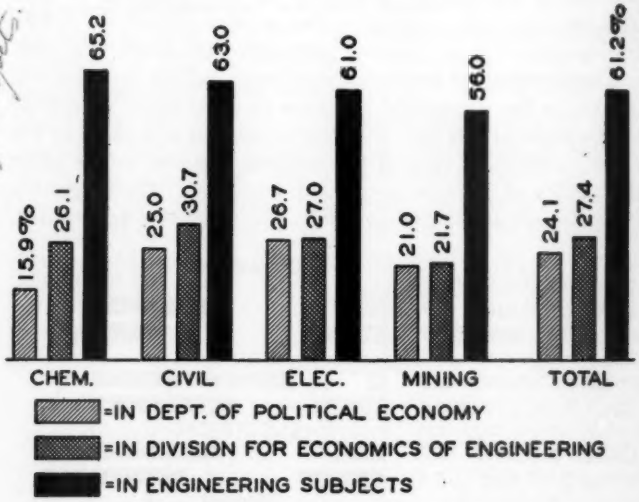

FIG. 9. Opinions of groups of engineers concerning the nature and place of measures to be taken to better the grasp of economic matters.

The supplemental comments emphasize the view that maturity and experience afford the chief basis of appreciation of and capacity to deal with the economic problems of engineering. Many state that the principles of economy are best dealt with concretely in the engineering subjects proper and by teachers with an adequate engineering background. A number express the view that the present scheme of instruction is inverted in its emphasis, overstressing the scientific and technical side of engineering at the expense of the economic. Few if any of the comments advise the omission of general eco-

nomics, but a number characterize the usual presentation of the subject as "inadequate," "abstruse" or the like. While the distinction was not explicitly stated in the wording of the questions, many of the commentators seem to accept *economics* as a relatively abstract science of wealth and *engineering economy* as a concrete effort to arrive at the best ratio of utility to cost. Most of the suggestions for improvement point distinctly in the latter direction.

G. The Use and Value of Modern Foreign Languages

One of the striking changes in engineering education during the past fifty years has been the declining attention to foreign languages.[5] Much of this decline has been attributed to the development of an abundant scientific and technical literature in the English language and to the lessened dependence of the modern engineer on foreign publications. Four of the groups of engineers were asked to indicate *the extent to which they have used foreign languages* in their business and professional activities, *which languages they have employed* and their views on the question:

"Are modern foreign languages, as generally taught to engineering students, justified by their cultural value in proportion to the time expended?"

The replies to the first question, as shown in Fig. 10, make it plain that the leading men of the engineering fraternity in America make relatively little use of foreign languages. As might be expected the degree of use is highest among the chemical engineers, who are still somewhat dependent on European publications for contact with the advances of the art. The mining engineers probably stand first in the spoken use of foreign languages.

French and German stand out strongly as the languages in the greatest use, Spanish being of relatively high importance only to mining engineers. The estimates of the cultural value of foreign language as generally taught are highly consistent. They speak for themselves.

[5] See Bulletin No. 11 of this series, p. 12.

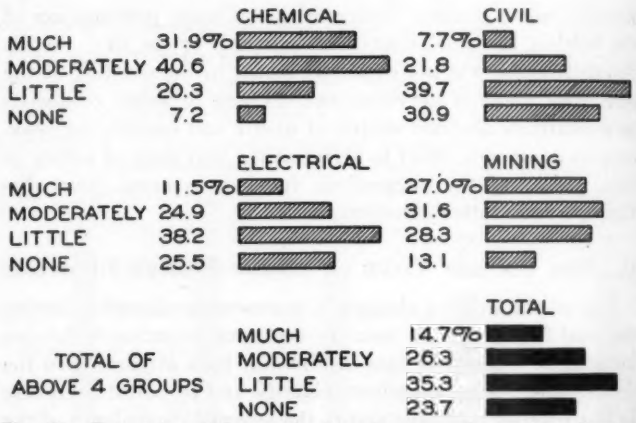

FIG. 10. Extent to which groups of engineers employ modern foreign languages.

The modern language question elicited numerous comments. Many state that language study is properly a part of preparatory education. Those who advise that the engineering student should get a working knowledge of at least one foreign

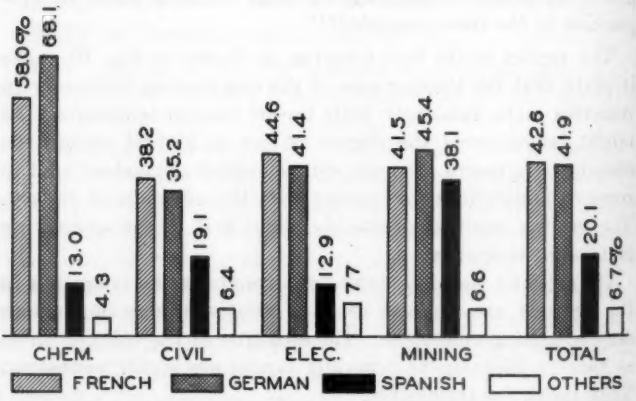

FIG. 11. Percentages of four groups of engineers who use the several foreign languages.

language stress facility in reading more often than ability to converse. German and French are suggested as desirable about twice as frequently as Spanish. Naturally, there is a body of comment definitely opposing required foreign lan-

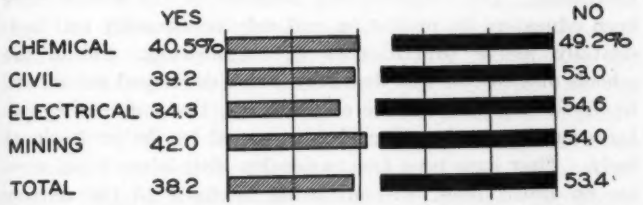

FIG. 12. Replies of groups of engineers to question, "Are modern foreign languages, as generally taught to engineering students, justified by their cultural values?"

guage study in the engineering curriculum. Many frankly characterize such work as waste of time with the usual type of teaching. It is often stated that languages are not mastered well enough to be of real value and that the environment needed for their mastery is lacking in America. A number of comments voice a preference for other media of culture, many definitely advising that the time should be given to English and public speaking.

Taken as a whole, the formal and informal opinions do not seem to place a value on the foreign languages which would justify their general retention as required work. A thorough reading knowledge of at least one language other than English, gained principally in preparatory work and extended where necessary through elective study in college, would seem to meet with general approval. Little can be said, however, in favor of scattering the student's effort among a number of languages without fair mastery of any. It is worth noting that a number of those who offered comments would place Latin on a par with the living tongues.

PART III. THE INFLUENCE OF THE NATIONAL ENGINEERING SOCIETIES IN ENGINEERING EDUCATION

Backgrounds.—The development of the engineering colleges in America has been almost exclusively an educational movement. The founders and directors of the schools have been educators by profession and only occasionally and incidentally active practitioners of engineering. Unlike the schools of medicine and dentistry which developed out of and finally displaced a scheme of pupillage, the engineering colleges have never been largely dominated by the professional body. They have been free to develop their educational service on broad lines, without being confined to the narrow boundaries of a strictly technical professional discipline. On the other hand, there has been little fostering of the schools by the engineering profession, no protection has been thrown around substantial standards and no moral influence has been brought to bear on institutions of uncertain quality. The engineering societies have not consistently recognized the work of the colleges as a substantial professional preparation; in one instance credit toward membership requirements allowed for graduation from an arduous four-year course is the same as that given for one year of experience in installing conduit and wire for an electrical contractor.

Significance of the Issue.—The engineers who sent in returns recognized the questions which dealt directly with the influence of the profession in engineering education as being of broad significance. The answers were evidently weighed with care. The comments which accompany them deserve careful appraisal as data of equal moment. Behind both the direct answers and comments stand the replies to the whole group of questions summarized in Part II. This body of opinion deserves to be recognized no less than the direct verdict on the issue, as an index of the desire of engineers to share in shaping the standards and processes of engineering education and of their capacity to deal constructively with the problems involved.

The Question of General Policy.—This question was formulated as follows:

"Should the engineering profession through the national societies, exercise a more direct influence in engineering education?"

Each individual was asked to frame a written opinion. There was no series of ready-made replies from which a choice might be checked. While the necessity for thinking out and formulating a reply was doubtless a factor in reducing the number of direct answers, a strikingly large number took the trouble to do it. In some cases a non-committal attitude doubtless reflected a state of unpreparedness to meet the issue or inability to visualize the means through which a favorable opinion might be given effect. If only the definite expressions of opinions are considered the ratio of those who favor a more direct influence to those opposed is practically nine to one.

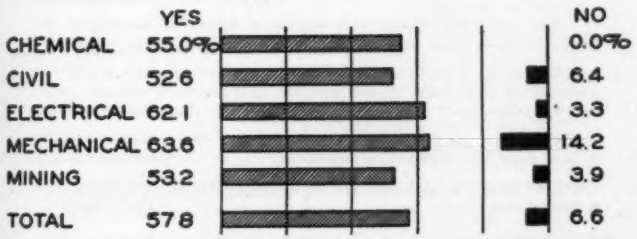

FIG. 13. Replies of groups of engineers to question, "Should the national engineering societies exercise a more direct influence in engineering education?"

Emphatic Endorsements.—There were many comments endorsing the proposal for a larger influence by the national societies in strong terms. A few representative samples follow:

> "I think this is one of the most important functions of the profession through the societies." (Consulting engineer)
>
> "As an employer of many chemical engineering graduates I have been convinced of the necessity for close cooperation between the engineering societies and the colleges." (Consulting engineer)
>
> "The engineering societies could not be engaged in a better or more laudable work. The societies are eminently qualified to serve and should exercise a direct influence in educational matters." (Consulting civil engineer)

"Yes. For the salvation of the profession."
(Consulting civil engineer)

"Emphatically *yes!* The profession can advance but poorly under the tutelage of inferior vision or cloistered technology."
(Construction engineer)

"Yes, in helping to develop some plan whereby such education, cost and effort is not wasted on poor material not qualified for engineering work." (Chief electrical engineer)

"I consider such cooperation necessary."
(Consulting electrical engineer)

"Yes. This is of vital concern to the future of the profession and the engineering societies should consider it a duty and obligation." (Consulting mechanical engineer)

"Very important not only for the profession but for the industries in general." (Vice-president, manufacturing co.)

"I believe the engineering societies can exert a profound influence." (Vice-president, manufacturing co.)

"Yes, it would be helpful and constructive."
(President, mining engineer)

"Yes, especially should this become a means of contact as between business firms and the colleges." (Dean, school of mines)

"The national societies should be the medium through which the engineering profession should attempt to promote and guide engineering education." (Research engineer)

"Certainly. If graduate coaching is good for athletics, why is it not good for engineering education." (Superintendent)

"The national societies should guide technical education with a strong hand." (Vice-president)

Guarded Endorsements.—On the other hand many comments sounded a warning against intrusion or imposed standardization and suggested that the influence of the national societies should be purely advisory. Examples:

"Yes, in helping us to estimate long time results and prospective needs. But, for the Lord's sake, don't presume to tell us how."
(Dean, engineering college)

"They might give advice but should not dominate or dictate."
(Metallurgical engineer)

"The A. I. M. E. may rightly act as a forum for the discussion of undergraduate education, but it should not take unto itself the official function of dictating or otherwise 'cooperating' in such matters." (Mining economic analyst)

"Not necessarily direct, but should exercise some real influence."
(Vice-president, coal and iron co.)

"Moral suasion. The Society is fussing with too many things."
(District manager, manufacturing co.)

"The influence should be to inspire and guide, not to dictate." (Editor)

"Advisory only—and then when asked." (Bridge engineer)

"If the engineering profession through the Societies indicates the qualifications or education necessary for a successful career, then the colleges through their professors will meet these requirements. This should be left to the colleges to work out." (Civil engineer)

"Difficult to avoid relations being perfunctory or else amateurish." (Manager, electric power)

"Should encourage and stimulate, but not dictate or attempt to dictate." (Personnel manager)

Adverse Comments.—Still another group gave voice emphatically to an attitude of "hands off:"

"Mind your own business. Don't meddle with things you don't understand. I have taught for fifty years and don't know much yet. How can you know if you haven't taught at all?" (Professor of mining)

"No. I do not believe this is the natural function of such societies." (Electrical engineer, railroad)

"The affiliation is already too close. It even now does much to prevent independent thought and action." (Consulting electrical engineer)

"It is impossible for the engineering profession to express itself through the national societies in a helpful way. The educators in the universities might just as well and as effectively seek to direct the engineering profession." (Chief municipal engineer)

"I feel that professional opinion is so unformed that it can have but little effect on the colleges." (Transportation engineer)

"Doubtful as to any closer relation. The fields of the schools and the societies are distinct and do not lend themselves to a great cooperation." (Geologist, steel company)

"No. All such questions should be left to experts." (President and gen. manager)

"The mass of the members will not participate and the activities will gravitate to the control of a small group of doctrinaires who will use the Society to promote their own notions." (Chemical engineer, lead co.)

Suggested Forms of Cooperation.—Many of the comments include incidental suggestions as to methods of cooperation between the societies and the colleges. A number of these are classified and tabulated below:

TABLE I

FORMS OF COOPERATION BETWEEN ENGINEERING SOCIETIES AND COLLEGES

	Chem.	Civil	Elec.	Mech.	Min.	All
An active Committee on Education in each society	1	16	15	8	4	44
Send able engineers to colleges as lecturers	1	6	7	1	6	21
Appoint engineers as advisers or as members of college boards	1	1	1	7	3	13
Chief contact through student chapters		8	5			13
Repeat inquiries of this type at intervals	2	3	2	5	1	13
Send official visitors to the colleges	1	1	3	2	1	8
Create joint national Committee on Education	1	3	1	3		8
Provide scholarships, prizes and medals		5	1	2		8
Get teachers to join the societies and attend meetings	1	2	2	1	1	7
Work through the S. P. E. E.		2	3	1	1	7
Encourage competent men to accept professorships	1	2	1	1	1	6
Get agreement on qualifications desired in graduates	1		1	3	1	6
Assist teachers to gain experience in practice		1	5			6
Recommend specialized portions of curricula			1	3	2	6
Have students get experience before graduation		1	4		1	6

In addition to the suggestions tabulated above several comments urge the societies to promote the cooperative plan, to help create and supply text material and data, to encourage the students to join the societies, and to link up the colleges with the sectional divisions of the societies.

Recognition of Colleges.—The national engineering societies participating in these studies enroll student members, maintain student chapters or branches, and grant credit toward membership requirements to graduates of "approved" or "recognized" engineering colleges.[6] The by-law regulations covering these activities are quite general in definition and scope and are applied by the officers of the societies in a confidential discretionary manner. As a result, the engineering profession has exercised practically no open influence in establishing or sustaining educational standards or in guiding the public to discrimination between sound, marginal and deficient institutions calling themselves "colleges of engineer-

[6] The A. I. Ch. E. does not enroll student members and makes no mention of "recognized" colleges in its membership regulations.

ing." Its position in this matter has differed markedly from that of other nationally organized professions, such as law, medicine, architecture and dentistry. It seemed pertinent to extend the general question concerning the influence of the engineering profession on engineering education into a more concrete issue:

"Specifically, and as one means of exercising a direct influence on engineering education, do you believe that the . . . (Name of Society) . . . should maintain and publish a list of approved institutions whose graduates would receive credit for a substantial part of the requirements for membership and in which student branches would be recognized?"

Following this question it was asked:

"If so, on what principle or basis should such a list of approved institutions be drawn up?"

A list of items was appended so that answers might be made by checking. The replies to the two questions stated above are summarized in Figs. 14 and 15.

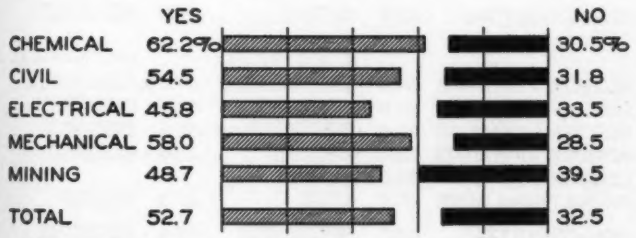

FIG. 14. Replies of groups of engineers to question, "Should the national engineering societies maintain and publish a list of approved institutions?"

By comparing Fig 14 with Fig. 15 it will be noted that the more concrete aspect of the problem with a choice of answers suggested resulted in a more definite taking of sides. The suggestion for a list of "approved" institutions is favored by a decisive plurality of each group and a small majority of the entire group. The ratio of approval to disapproval varies

from a minimum of 1.24 to 1 in the mining group to 2.04 to 1 in the mechanical group, with a weighted average of 1.61 to 1 for the five groups.

Basis of Recognition.—The expression of opinion on the contingent question of the basis on which such an approved list should be drawn up was naturally confined almost exclusively to those who had indicated an approval of the plan in principle. The electrical engineers, however, registered more strongly on the particulars than on the principle. It may be noted that practically all who favor an approved list in principle favor basing it in part on the total graduation requirements; over ninety per cent favor giving weight to the

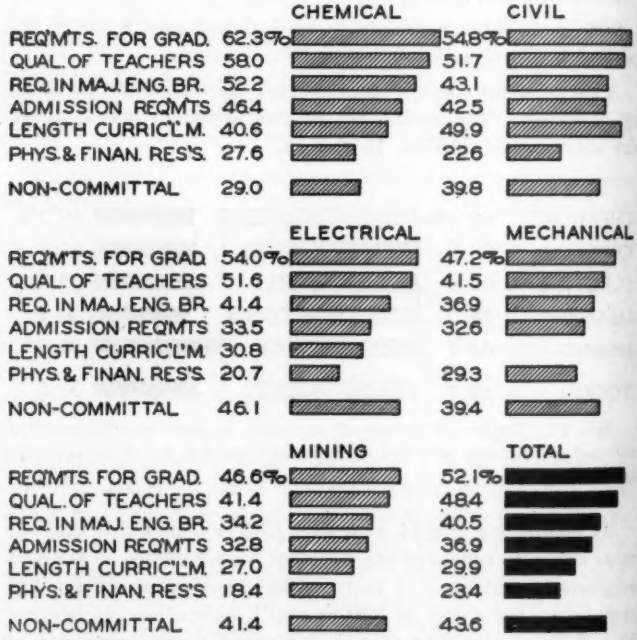
CHEMICAL
CIVIL
REQ'MTS. FOR GRAD. 62.3% 54.8%
QUAL. OF TEACHERS 58.0 51.7
REQ. IN MAJ. ENG. BR. 52.2 43.1
ADMISSION REQ'MTS 46.4 42.5
LENGTH CURRIC'L'M. 40.6 49.9
PHYS. & FINAN. RES'S. 27.6 22.6
NON-COMMITTAL 29.0 39.8
ELECTRICAL
MECHANICAL
REQ'MTS. FOR GRAD. 54.0% 47.2%
QUAL. OF TEACHERS 51.6 41.5
REQ. IN MAJ. ENG. BR. 41.4 36.9
ADMISSION REQ'MTS 33.5 32.6
LENGTH CURRIC'L'M. 30.8
PHYS. & FINAN. RES'S. 20.7 29.3
NON-COMMITTAL 46.1 39.4
MINING
TOTAL
REQ'MTS. FOR GRAD. 46.6% 52.1%
QUAL. OF TEACHERS 41.4 48.4
REQ. IN MAJ. ENG. BR. 34.2 40.5
ADMISSION REQ'MTS 32.8 36.9
LENGTH CURRIC'L'M. 27.0 29.9
PHYS. & FINAN. RES'S. 18.4 23.4
NON-COMMITTAL 41.4 43.6

FIG. 15. Matters to be considered in drawing up a list of approved institutions, as recommended by five groups of engineers.

qualifications of the teaching staff, more than seventy-five per cent to the requirements in the major branch of engineering, and seventy per cent to the requirements for admission; but only a minority of those favoring the plan would consider the physical and financial resources of the institution. In short, a sound course of study and an adequate staff, and not endowment and plant, are ranked as primary qualifications.

Comments on an Approved List.—As might be expected, the questions relating to an approved list of institutions drew forth a large volume of comment. In the main three positions are taken, endorsement, endorsement of principle qualified by doubts of practicability, and emphatic disapproval. The questionnaires supplied no information concerning the rapid spread of weak or marginal institutions and the increasing proportion of the total enrollment in institutions of this character. Each person was left to estimate the degree of exigency for himself. The comments repeatedly strike the note, "Consider the student, not the school." The opinion is often expressed that the selection of such a list of institutions would require careful investigation and great discrimination, that the societies are not at present set up to handle a problem of this nature, and that great care would be needed to keep such a list from becoming a mere routine and perfunctory matter.

Editorial Comment.—Considering the radical departure from the traditional policy of *laissez faire* which these proposals for the recognition of institutions involve and the admitted difficulties to be faced in putting them into effect, the favorable verdict seems to carry great weight. The successful handling of the matter would seem to call for close cooperation among the five societies of engineers and with the Society for the Promotion of Engineering Education as representing the colleges. There is no indication of a desire on the part of any of these bodies to impose a rigid standardization or classification of colleges such as exists in the fields of medicine and dentistry. Reasonable minimum qualifications for the recognition of an institution "as a college of engineering" to serve as a safeguard to the public and to the engineering profession, stand approved in principle.

SECOND SECTION—SUMMARIES OF SEPARATE INQUIRIES

In the following section are set forth in summary form the results of the inquiries which relate to the several professional divisions of engineering education. The facts concerning the qualifications of each group of engineers are given briefly, and selections from the general comments on engineering education as a whole. The professional divisions are presented in alphabetical order.

PART IV. CHEMICAL ENGINEERING

Engineers Consulted.—All but two of the sixty-nine replies summarized came from college trained men representing twenty-five American and several foreign institutions. Nearly forty-four per cent were trained in chemistry, nineteen per cent in chemical engineering, and the remainder in miscellaneous fields. The two largest groups, according to the type of practice, are in manufacturing and consulting respectively with more than thirty per cent each. Industrial executives make up thirty-six per cent, research engineers about twenty per cent and educators about twelve per cent of the entire group, the remainder being scattered under many heads.

Nature and General Content of Curricula.—The opinions of chemical engineers included in the graphical tabulations of Part II may be summarized as follows. The curriculum should be fairly distinct from those in other major branches of engineering in order that adequate grounding in chemistry may be given. It should be broad in scope and include foundation studies in mathematics, physics, general chemistry, English, drawing, mechanics, economics, modern languages, elementary electrical engineering and heat engineering in common with other branches of engineering. Instruction in hydraulics, surveying and business law is less favored by chemical engineers than by engineers in other branches of the profession. Some introduction to the problems of management is given a fairly high rating, though recommended by less than a majority and for comparatively few students. A majority favor a preponderantly technical program with business electives and fair sized groups advise supplementary studies in business branches after graduation. The economic aspects of engineering deserve moderately great emphasis, to be given principally in the engineering subjects themselves. Chemical engineers, more than any other group, report a considerable use of modern languages, principally German

and French, and recommend their being required in the college curriculum. The tool values of these languages are stressed above the cultural values.

Shop Instruction.—In response to a specific question, a small majority of the chemical engineers, or 55.1 per cent, favor systematic instruction in shop practice. Opinion is fairly equally divided on the question of substituting for shop instruction in colleges a requirement that a definite amount and type of shop experience be obtained during vacation periods, with 40.6 per cent favorable, 37.7 opposed, and 21.7 noncommittal.

Specialization in Chemical Engineering.—Three important questions were considered:

a. "Which of the several divisions of chemical technology and closely allied fields are of such importance as to warrant their inclusion in the training of all chemical engineers?"

In asking this question it was assumed that an adequate grounding in chemical principles and a consideration of fundamental chemical engineering operations such as evaporation, distillation, filtration, subdivision, etc., would be included in all cases. The replies are summarized graphically in Fig.

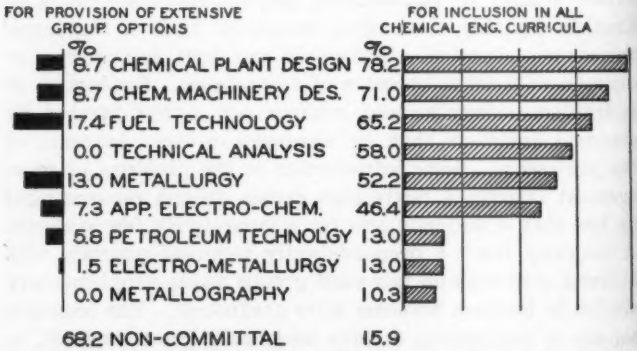

FIG. 16. Divisions of chemical engineering recommended for inclusion in all chemical engineering curricula, or to serve as the basis of extensive group options.

16, and indicate clearly where the line may be drawn between the more general and the more special concerns of chemical engineering.

b. "Should the instruction in the specific chemical engineering subjects aim to prepare men for particular fields of work, such as those listed above, or should they serve primarily as means of teaching fundamental scientific principles and engineering methods of thought and work?"

The verdict on this point is impressive, the latter or more general aim being affirmed by a ratio of twenty-two to one.

c. "Which, if any, of the above divisions of chemical and related technology are of such importance as to warrant the provision of extensive group options in the chemical engineering curriculum?"

The graphical summary of the replies is included in Fig. 16 above.

Considering both the informal comments and the tabulated replies, the verdict is strongly adverse to specialization within the field of chemical engineering for undergraduates. A few favor limited specialization through group options in a few institutions, but the majority would postpone all specialization until after graduation or after college.

Relations with the Organized Profession.—Chemical engineers stand out conspicuously in favoring a more direct influence by the engineering profession, through its national societies, on engineering education and in favoring the formal recognition of colleges which meet approved minimum requirements. No doubt the experience of the A. I. Ch. E. in scrutinizing curricula in chemical engineering and in publishing a list of those approved by its educational committee was a considerable factor in the more positive and favorable expression than that given by other groups of engineers.[7]

General Comments on Engineering Education.—The following examples reflect the temper of the chemical engineering group:

[7] See Report of Committee on Chemical Engineering Education of the American Institute of Chemical Engineers, 1922, *Journal of Industrial and Engineering Chemistry*, May 1921.

"Each year I am the more certain that the basic education of chemists, engineers, etc., should be broad, general, liberal, and that the engineering training should follow." (President of firm)

"I doubt if more than one engineering student out of a hundred knows exactly what line of work he will eventually follow. Consequently, the time which is given to specific processes is largely wasted. It seems to me that the first requirement in education is the teaching of straight thinking. Next it is necessary to have sufficient fundamental information, which for the chemical engineer should include a real understanding of mathematics, physics, chemistry and economics. The ability to write well is highly desirable and the ability to read German and French is helpful. If these subjects are covered thoroughly there is not much time left in a four-year course for engineering technology."
(Research director)

"Education, in my opinion, is a question of *habitual* familiarity with ideas, subjects, methods and actual performance, rather than a question of knowledge *about* them. This habitual familiarity can only be acquired through training one's own faculties, not by watching someone else perform or listening to some one else talk about how a third person performed. Most of what we learn about things in college is quickly forgotten. A great deal of it is more or less incorrect anyway. We can find it in books if we need it. If we are any good we can hire some one to stand around and know it for us. But we must aim to compel the student to acquire by practice the faculty of using his own mental tools, his human tools and his mechanical tools with force, precision and dispatch on any material in any direction." (Consulting engineer)

"Education is the foundation on which men are built, and success is not to be measured solely by dollars. Specialized engineering education does not develop men fitted for the emergencies which afford opportunities for advancement, neither is the product well rounded and interested in many things, outside of his specialized business, which were once considered as natural outlets for the spare time of the well educated men. Broad training and a continuance through college years of courses in the humanistics should give the type of man needed in the industries."
(Consulting engineer)

"A consideration would be useful of methods by which we could *separately* educate the artists and the artisans of engineering. I don't know how to make the original choice but I think we all know how to educate the two groups once the choice were made."
(Research director)

"A rigorous and thorough training in fundamentals should characterize the engineering course. Specialization should be reserved for graduate courses. Plant practice should be learned and studied in the field." (General manager)

PART V. CIVIL ENGINEERING

Engineers Consulted.—The civil engineers whose opinions are summarized are college trained men in the ratio of five out of six and represent forty-four American institutions and several in Europe. Seventy per cent were graduated in civil engineering. Classified according to type of connections, the group in private practice is first with 45 per cent, the municipal group second with 13 per cent, the educational group third with 12 per cent, with the groups in federal, railroad and state service, and in manufacturing following in order with less than ten per cent each. Consulting engineers and chief engineers together make up one-third of the group, and men in the higher executive positions one-fifth. The structural branch of practice leads with 23 per cent, the hydraulic branch is second with 15 per cent and the other principal branches are represented by groups ranging from ten to three per cent of those who replied. Taken as a whole, the body of opinion is representative in variety and notable in quality.

Nature and General Content of Curricula.—The opinions of civil engineers included in the graphical tabulations of Part II may be summarized as follows. The program in civil engineering should not be largely differentiated from those of kindred branches of engineering. There should be a broad base of studies in common with other curricula, including mathematics, physics, chemistry, English, drawing, mechanics, mechanics of materials, hydraulics, economics, plane surveying, elementary electrical engineering and business law. A marginal ranking is given by civil engineers to accounting, modern languages and heat power engineering. A majority favor giving some specific instruction in the realm of administration and management, but there is no clear verdict whether this instruction shall be for all students or only for those who desire to elect it. There is no desire to substitute a business emphasis for a dominantly scientific and technical emphasis of the curriculum. Sentiment is about equally divided between offering business electives as a part of the nor-

mal undergraduate program and advising special study of supplementary business subjects after graduation.

Civil engineers favor a moderately great emphasis on economics and the economic aspects of engineering, principally through the medium of the engineering subjects themselves. They report both the younger and the more experienced graduates to be less well equipped to deal with the economic problems of engineering than with the technical problems. Nearly seventy per cent of the civil engineers report little or no use of modern foreign languages. German and French are used nearly twice as much as Spanish. A majority hold that the cultural values of modern languages as commonly taught to engineering students are not sufficient to justify the time expended.

By the ratio of five to three the consensus of opinion among civil engineers is that courses in shop practice should not be required of civil engineering students.

Specialization in Civil Engineering.—This subject was dealt with under four questions:

a. "Which of the following specific civil engineering subjects do you consider of such importance as to warrant inclusion in the training of all civil engineers?"

The replies are summarized graphically in Fig. 17. Plane surveying and the structural group stand out strongly, with the sanitary group second and the transport group third among the subjects of primary importance.

b. "Should the instruction in specific civil engineering subjects aim to prepare men for particular fields of work, or should such subjects serve primarily as means of teaching fundamental scientific principles and engineering methods?"

The verdict on this question is emphatic, favoring the latter or more general aim by a ratio of seventeen to one.

c. "Which if any of the divisions of civil engineering are of such importance as to warrant the provision of distinct, complete curricula specializing in these divisions?"

The replies are summarized graphically in Fig. 18. If only

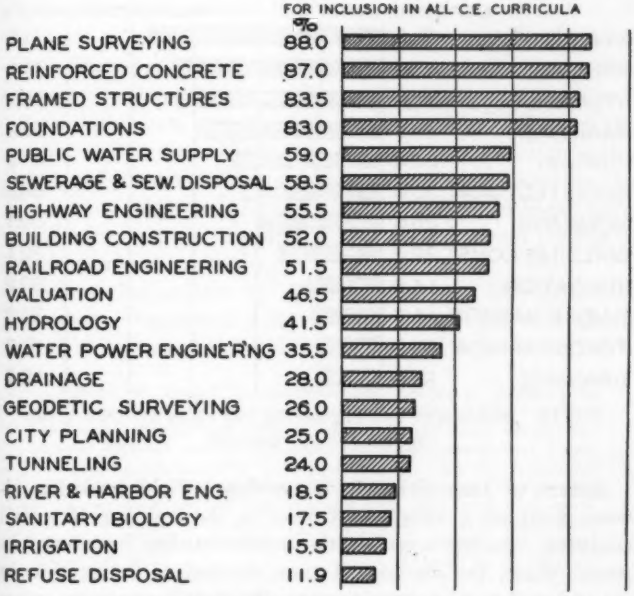

FIG. 17. Civil engineering subjects recommended for inclusion in all civil engineering curricula.

the specific replies to the question are considered, it would seem that considerable support is given to distinct curricula, or at least comprehensive options, in structural, sanitary, hydraulic and railroad engineering. Many of the informal comments which accompany these answers indicate that specific training of this character should be confined largely to post-graduate courses.

d. "If curricula in specialized branches of civil engineering are recommended, should they be established in all, many, or few institutions?"

Nearly two thirds of the specific replies, or 64.3 per cent, recommend *few* institutions; 26.3 per cent recommend *many;* and 9.3 per cent recommend *all.*

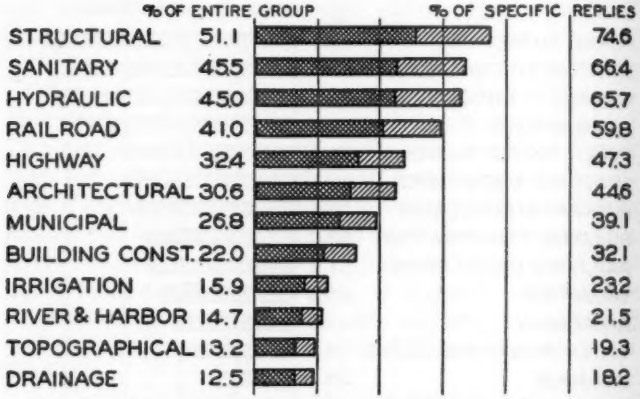

FIG. 18. Divisions of civil engineering for which extensive group options are recommended.

Extent of Instruction in Surveying.—Field work has always occupied a conspicuous place in the training of a civil engineer. As the scope of the profession has broadened in recent years, the amount of time devoted to instruction in surveying has been questioned. The civil engineers were asked to indicate:

"Which of the divisions of surveying should be required of all students of civil engineering and how extensive should the work be in each division?"

A graphical summary of the replies is given in Fig. 19.

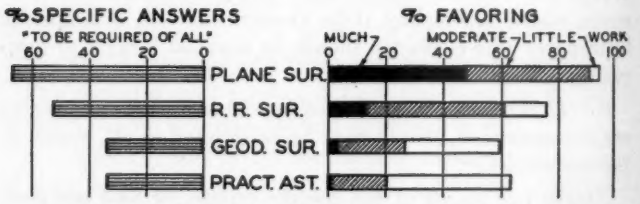

FIG. 19. Recommendations concerning branches of surveying to be required of all civil engineering students and the extent of the work in each branch.

The number who marked the blanks indicating the extent of the work to be given was somewhat greater than the number who indicated which divisions should be required of all. The two sets of replies are consistent in a qualitative sense.

Relations with the Organized Profession.—If only the specific replies are considered, the civil engineers have decisively expressed their desire for a closer bond between the professional body and the colleges and have commended by a considerable margin the proposal to maintain and publish a list of approved institutions.

General Comments by Civil Engineers.—The following comments on engineering education in general are representative of the views of the civil engineering group:

"There is danger in generalization. Different treatment is needed for various colleges and possibly for same college at different times. Students of different capacities and aims should find suitably different courses of training somewhere among the colleges, but not necessarily with the same college. Between secondary schools and the ultimate terminus of formal education there should be one or more way stations at which men could stop with credit and even honor, or transfer to other lines for completing their schooling. Education cannot be completed in schools, and schools should not try." (Director of foundation)

"An engineering education assumes that the student is to practice his profession and he must be taught the fundamentals which cannot be learned out of school. He must graduate young enough to take a subordinate position and continue learning and profiting by experience while still young. In this view, the amount he can be taught at school is limited." (Chief engineer, transit)

"We must get the idea established that we are no longer being called upon to send out finished technicians for a few fields, but are preparing men for entrance to many fields, some new. Broad training in general and thorough preparation in basic subjects is what is needed." (Professor)

"An engineering education should give the student broad, general knowledge of engineering subjects and related economics. Specialization should be made of one of the major divisions, as Civil or Electrical, but not more finely divided, as Hydraulic or Sanitary. It is rare to have a graduate start practicing on a specialty when he leaves college." (Superintendent of highways)

"It should aim to train in fundamental principles, and to develop initiative, power and logical thinking. It should not be vocational—as it now generally is—aiming to teach the tricks of some particular job." (Professor, author, consultant)

"I believe in fundamentals for the majority and in training equivalent to that received by Doctors of Medicine for the qualified few. We must train many transitmen and a few chief engineers. It is uneconomical to train too many for chief engineers' positions."
(Railroad valuation engineer)

"My observation is that most engineering graduates come out very poorly grounded in the fundamentals of engineering. Sometimes this is the result of robbing the time and the mental concentration which the student should have put on his physics and mathematics by giving him courses on tunneling, irrigation, highway engineering or what not." (Consulting engineer)

"I do not believe engineering schools should all be modelled on one pattern. Schools ranging from trade schools to schools of university rank can each cover a useful field. Those capable of making effective use of broad training should be able to obtain it, but provision should also be made for those less capable or for financial reasons not able to profitably use this broader opportunity." (Consulting engineer)

"Let us have more men who have insight into the economic and social life of people rather than the type of engineering graduate who knows little else than engineering." (General superintendent)

"Students should be encouraged to take an academic course, including literature, languages both modern and dead, political economy, psychology, etc., before beginning an engineering course, as these things are essential to enjoyment and success in life. But they cannot be covered satisfactorily in an engineering course without sacrifice of many fundamental necessities."
(Valuation engineer)

"Number of engineering schools should be materially reduced. Number of engineering students should be given short courses, for subordinate positions, and only the most capable men given engineering training of the upper years. Teaching should be supervised and materially improved." (Professor, consultant)

"I consider it hopeless to achieve what might be desired in the way of engineering education if we limit it to a four-year college course, while much might be done towards securing better preparation for entering engineering institutions of learning, much more can be accomplished by encouraging the continuation of engineering education after the regular four-year course."
(Rear admiral, U. S. N.)

"I believe that the engineer's horizon should be broadened, his vision cultivated, that he should be trained to see his profession not as a thing apart, an isolated entity, but rather in its proper place in the general scheme of social and industrial evolution."
(Engineer, coast and geodetic corps)

PART VI. ELECTRICAL ENGINEERING

Engineers Consulted.—More than nine-tenths of the electrical engineers who sent replies had attended college, with fifty-six American institutions and a number in Europe

represented. Approximately seventy per cent of the college men were trained in electrical engineering and twenty per cent in mechanical engineering. In the lines of work represented, manufacturing ranks first, consulting practice second, the power and light utilities third, education fourth, and the communication utilities fifth. Nearly forty per cent of the group are higher executives in industry and more than a quarter are consulting engineers or chief engineers. The group as a whole is largely representative of the leading elements in the profession.

Nature and General Content of Curricula.—The opinions of electrical engineers included in the graphical tabulations of Part II may be summed up as follows. The weight of judgment is strongly against a course of studies which is sharply differentiated from those in other branches of engineering. The broad base of the curriculum, including the matter in common with other curricula, should include mathematics, physics, English, drawing, mechanics, mechanics of materials, heat power engineering, hydraulics, economics, shop practice, and business law. Modern foreign languages, accounting, surveying, industrial management, and psychology are placed in a marginal group. There is little support for specialization within the field of electrical engineering, but a majority of electrical engineers see merit in the functional plan of curricula proposed by their colleague, Professor Bennett, and the ratio of those who would give the plan a trial to those who would not is practically four to one. Doubtless greater familiarity with the idea underlying the functional plan was a factor in this more favorable verdict than that of other groups of engineers, for the plan had been presented in detail in the *Journal* of the A. I. E. E.

Half of the group advise that students of electrical engineering should receive specific training in administration and management, with a minority opposed. Relatively few, however, recommend that this training be given to all students. The majority favor a dominantly technical course of studies with business electives and a somewhat smaller group would

make the business studies required. There is a strong sentiment to the effect that economics and the economic aspects of engineering deserve relatively great emphasis, which should be given principally in the engineering subjects themselves. The younger graduates are found to be deficient in their capacity to deal with the economic problems of engineering, but considerable improvement is noted during the first five years of practice.

Shop Instruction.—In response to a specific question, a slight majority consider it desirable to substitute a definite amount and type of shop experience gained during vacations for systematic shop instruction in college. In rating the relative importance of different aspects of shop instruction, the majority (55.7 per cent) stress the technique of shop operations, a somewhat smaller group (39.2 per cent) the economic phases of shop operations, and much smaller groups manual skill (26.5 per cent), and the technique of management (25.1 per cent). In informal comments many emphasize the desirability of combining vacation experience with shop instruction.

Specialization in Electrical Engineering.—This issue was presented through a series of four questions:

a. "Which of the several divisions of electrical engineering are of such importance as to warrant their inclusion in the training of all electrical engineers?"

The replies to this question are summarized graphically in Fig. 20. It was taken for granted that a general foundation course in the principles of electrical and magnetic units, laws, circuits and machines would be required in every case.

b. "Should the instruction in the specific electrical engineering subjects aim to prepare men for particular fields of work, such as those listed above, or should they serve primarily as means of teaching fundamental scientific principles and engineering methods of thought and work?"

As shown in Part II, the latter or broader aim is favored by a ratio of nearly fourteen to one.

c. "Which divisions of electrical engineering are of such importance as to warrant the provision of distinct, complete curricula specializing in these divisions?"

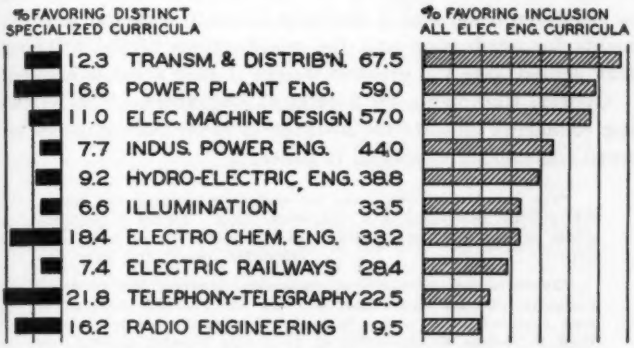
% FAVORING DISTINCT SPECIALIZED CURRICULA
% FAVORING INCLUSION ALL ELEC. ENG. CURRICULA
12.3 TRANSM. & DISTRIB'N. 67.5
16.6 POWER PLANT ENG. 59.0
11.0 ELEC. MACHINE DESIGN 57.0
7.7 INDUS. POWER ENG. 44.0
9.2 HYDRO-ELECTRIC ENG. 38.8
6.6 ILLUMINATION 33.5
18.4 ELECTRO CHEM. ENG. 33.2
7.4 ELECTRIC RAILWAYS 28.4
21.8 TELEPHONY-TELEGRAPHY 22.5
16.2 RADIO ENGINEERING 19.5

FIG. 20. Recommendations concerning divisions of electrical engineering to be included in all electrical engineering curricula, or to serve as the basis of distinct, specialized curricula.

A graphic tabulation of the replies is included in Fig. 20 above.

d. "If curricula in the specialized branches of electrical engineering are recommended, should they be established in all, many, or few institutions?"

As this was a contingent question only the minority who favor some measure of specialization replied. Of this number, seventy per cent would limit specialization to a few, and twenty per cent to many institutions. About one reply in twelve suggests specialized courses for all institutions; this number, however, is but a little more than four per cent of the entire body of replies. It seems evident that there is very little desire for closer specialization within the field of electrical engineering, before the graduate school or the years of active responsibility are reached. The comments emphasize this position strongly.

Relations with the Professional Body.—While strongly fa-

voring in principle a large influence by the national societies in engineering education, only a minority of the electrical engineers express approval of the proposal to establish and maintain a list of recognized institutions; the number opposed is somewhat less; and a majority indicate that the requirements for graduation and the qualifications of the teaching staff should have the greatest weight if such a list is created.

General Comments by Electrical Engineers.—The following comments indicate the attitude of electrical engineers toward engineering education in general:

"The broader we can make an engineer's training the better, but 'a little knowledge is a dangerous thing.' Better a thorough course in essential fundamentals than a smattering of many subjects." (Engineer, power and light co.)

"Specialization in electrical engineering courses has produced graduates who are technicians and not leaders. The position of chief engineer seems to be the goal. The broadly trained man is fitted to become an executive or to handle broader problems of management and operation. The small number of men who desire to become designers and research men can be prepared better in graduate courses featuring their specialties." (Editor)

"Specialization in his chosen field is necessary, but it should be preceded by general studies applicable to the fundamental principles of business conduct." (Consulting engineer)

"Thorough drilling in fundamentals is far better than teaching a lot of details which one can find in books. The chief feature in education is to teach one how to think and think correctly." (Consulting engineer)

"Business elements predominate in commercial engineering work. These are best learned through experience. Technical proficiency of graduates is on the wane and yet the fundamental technical knowledge is increasingly necessary. Teaching personnel the major objective to be desired." (Editor)

"I do not favor a standard stereotyped engineering school. We need many kinds, of course all of them good. I believe the public should be better protected against the poor schools, of which there are many, but this must be done without forcing conformation to a specific type." (Professor)

"Education must and does continue after graduation and it seems to me that a very great field for helpfulness exists in the proper direction of this subsequent education." (Chief engineer, telephone co.)

"Teach a man to demand sound and comprehensive evidence of the facts, give him a thorough understanding of principles, or laws of nature, and then teach him to build carefully on this foundation. Teach him to question, to think, to analyze, to demand an

understanding, not to learn by accepting what he is told; that habit is vicious. The subject or field is unimportant—*damn the curricula!*" (Professor)

"I believe we should have two engineering courses:

1. Electro-technicians—4 years.
2. Electrical engineering—4 years in general fundamentals followed by 2 years post-graduate in one of the major divisions of electrical engineering.
3. The degree of E.E. to be conferred only after the full six years' work." (Chief engineer)

"Admission qualifications should require that the applicant has worked at least twelve months in the branch of engineering which he is to take up in school. This would greatly assist the student in choosing his profession, and would enable him to get more benefit from his education." (Consulting engineer)

"If engineering is to maintain its position as a profession and not degenerate into a trade the cultural side of the college career must receive more attention than in the past. An engineer has his life to live as well as being the slave of a machine and his technical ability may be enhanced by a more intimate knowledge of the humanities." (Consultant, industrial relations)

"Engineering education should be an evolution with most institutions evolving by experience in their own way. Stimulus should come from individual leadership, criticism of alumni and the technical world, success of the institution, examples of others, etc. Not by formula or model or outside prescriptions."
(Consulting engineer)

"I believe the student of today has too much of his thinking done for him by others. More effort should be made to develop his initiative and self-reliance." (Design engineer)

"The most important thing is a proper grade of teacher. It is not logical to expect men who would be lined for very low positions in engineering or business enterprises to turn out a product capable of stepping readily into the higher positions."
(Head, research department)

"I am struck that a good engineer may be a very poor teacher. Something should be done to teach professors how to teach, which is an art in itself." (Development engineer)

PART VII. MECHANICAL ENGINEERING

Engineers Consulted.—The list of mechanical engineers contains a larger proportion of men without college training than the other four. The 82.4 per cent who report college training represent fifty-one American institutions and a number abroad. Four-fifths of the college men have taken the course in mechanical engineering. The largest group, classed by type of connections, are in manufacturing with

forty per cent of the whole number, fifteen per cent are in consulting service and seven per cent in public utilities. Half of the entire number, or sixty per cent of those stating their responsibilities, are industrial executives of high rank. Relatively few educators were included in the list canvassed.

Nature and Content of Mechanical Engineering Curricula.—The opinions of mechanical engineers included in the graphic tabulations of Part II may be summarized as follows. There is a marked preference for a broad general course of studies rather than one which is sharply differentiated from other branches of engineering. The foundation studies in common with other curricula should include mathematics, physics, chemistry, English, mechanics, mechanics of materials, elementary electrical engineering, thermodynamics, shop practice, economics, business law and industrial management, with accounting, industrial relations and modern languages given a marginal rating. There is a recognition of merit in the functional scheme of curricula by a moderate margin and a somewhat greater degree of approval for a trial of the plan, but the balance of opinion remains in the hands of the non-committal group. The comment on the functional scheme is principally adverse, stressing the inability of the boy to choose or of the school to classify, and opposing the plan as a form of specialization. There is a strong preponderance of favor for a moderate to great emphasis on economics and the economic aspects of engineering. More than two-thirds of the expressed opinions call for more economic emphasis in the engineering subjects themselves. By a decisive ratio of four to one, it is stated that engineering graduates are not now as well qualified to deal with the economic aspects as with the technical aspects of engineering problems. Comments on the teaching of economics uniformly call for a closer linking of the subject with engineering.

Specialization in Mechanical Engineering.—Four of the questions asked fall under this head:

a. "Should the purpose of the specialized mechanical engineering subjects be to prepare men for particular fields of

work, or should they serve essentially as media for the teaching of fundamental scientific principles and engineering methods?"

Preference for the broader purpose predominates by the ratio of five and a half to one.

b. "Which of the several divisions of mechanical engineering do you consider of such importance as to warrant their inclusion in the training of all mechanical engineers?"

The opinions are summarized in Fig. 21. The primacy of machine design is fairly striking. This branch with the two

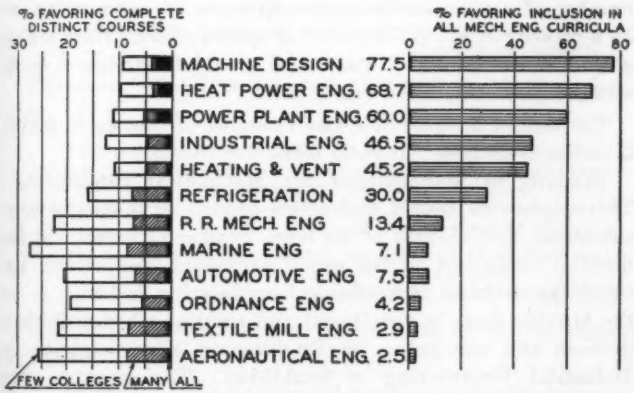

FIG. 21. Recommendations concerning branches of mechanical engineering to be included in all mechanical engineering curricula, or to serve as the basis of complete, distinct courses.

branches of heat power, make up the backbone of the distinctive training in mechanical engineering in the judgment of these engineers.

c. "Which, if any, of the above divisions of mechanical engineering are of such importance as to warrant provision for distinct, complete courses, such as courses in Automotive Engineering or Marine Engineering? Should these courses be given in all, many or few institutions?"

The replies are summarized graphically in Fig. 21. There is little demand or support for specialization in the divisions of mechanical engineering among this group of engineers, and it is plainly their desire that few institutions should carry specialization to the extent indicated by the question. Many would limit all specialization of this order to post-graduate courses. An engineer of the Bureau of Mines puts the case for limited specialization succinctly in the words: "A specialized course in anything should be available somewhere."

d. "In general, do you feel that the needs of industry and the profession would be better served by a relatively small number of courses in the major divisions of engineering, or by a rather considerable number of special courses from which a student could choose, and which would be designed to fit men for particular divisions of work?"

The verdict in favor of a small number of courses in major divisions is decisive, the ratio being five to one.

Training in Management for Mechanical Engineers.— The opinions expressed under this head deserve special consideration, first because of the large number of prominent industrial executives in the group canvassed, and second because the division of mechanical engineering is likely to be the heaviest loser in enrollment and prestige when a distinct division and curriculum in Engineering Administration or Industrial Engineering is established. The question was stated as follows:

"Do you think that the best preparation for this type of work is through sound courses in mechanical engineering with some attention to administration and management (possibly in the form of a subject of instruction given in the junior or senior year), or through special courses variously designated 'Engineering Administration,' 'Industrial Engineering,' and the like?"

In reply, seventy per cent express a preference for "sound courses in mechanical engineering," fifteen per cent for special courses emphasizing administration and management, and fifteen per cent are non-committal. The informal comments

elicited are particularly striking. A number voice emphatic disapproval of the special courses referred to:

> "There is so much humbug in this that I hesitate to answer."
> (Consulting engineer)
>
> "This generalized administration or executive engineering fad is being over done. Much of the Industrial Engineering of today is bunk." (President, manufacturing co.)
>
> "It is folly to suppose that green students can profitably spend time on management when they have had no experience."
> (District manager, tool manufacturing co.)
>
> "Special courses in management often mistake the mechanics of management for the principles and the graduates of such courses have too much to unlearn." (Superintendent)
>
> "It has always seemed to me that the courses in Administration and Industrial Engineering are refuges for the incapable."
> (Power plant engineer)

The other side of the issue has its strong upholders, however:

> "The coming basic engineering course, I believe, will be a development from existing courses designated as Management Engineering, Industrial Engineering and the like. Therefore I believe instruction of this kind should be given to every engineering student." (Editor, management journal)
>
> "All engineers should be taught the principles of management, even if some of the other courses have to be sacrificed."
> (President, manufacturing co.)

The following statement is representative of the median opinion:

> "A relatively brief time, devoted mainly to lectures by mature experts who are enthusiastic and broad in methods, will be sufficient. This calls for the highest grade of teaching."
> (Consulting engineer, lead co.)

Instruction in Shop Practice.—In view of the diversity of opinion in teaching circles as to the scope and purposes of shop instruction, the following questions were asked of the mechanical engineers:

a. *"What, in your opinion, should be the primary purpose or purposes of such courses—training in manual operations and acquirement of skill therein, training in management and production methods, training in the economics and business aspects of shop work, etc.?"*

The replies are summarized in Fig. 22.

b. "In your opinion would it be desirable to require students to acquire shop experience through vacation employment, provided, of course, that practical plans could be devised, or is it desirable to give some shop training in college?"

The replies are shown graphically in Fig. 22.

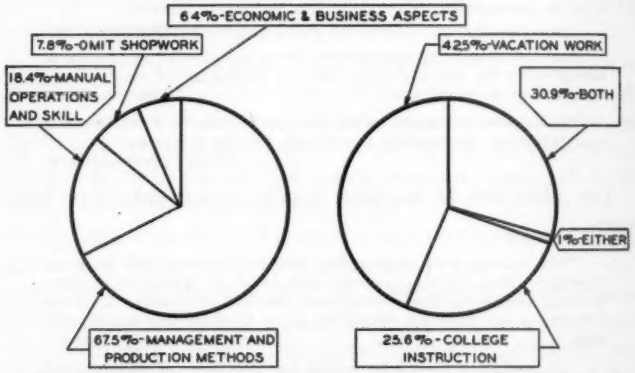

FIG. 22. Methods of training in shop practice (right) and aspects to be emphasized in college instruction (left), recommended by mechanical engineers.

The comment on these questions emphasizes the fact that the college is better organized to do systematic teaching, but that real knowledge of men and methods can be had only through industrial experience. It would seem, however, that mechanical engineers are disposed to give this type of instruction less emphasis than hitherto, and favor more emphasis on the laboratory aspects than on manual training. Many express the view that the latter properly belongs to the high school period and to vacation experience.

Influence of the Organized Profession in Education.—The mechanical engineers stand first among the five groups in the proportions of replies which definitely favor and definitely oppose a more direct influence in engineering education by the national societies. In approving the proposal to set up

a list of approved institutions they rank second to the chemical engineers in favoring the plan and show a smaller degree of definite opposition than the other groups.

General Comments on Engineering Education.—The following have been selected as indicating the range and trend of opinion among mechanical engineers:

"I believe the society can do much through a careful study of the answers to this questionnaire to improve the character of the courses offered in the schools of the country."
(Vice-president, utility co.)

"I believe the A. S. M. E. and other engineering societies should advocate a much more adequate teaching of the sciences not only in the general college courses (non-engineering) but also in the schools down to even the lower school grades. The ignorance of our average citizen as to the great modern developments in science and his ignorance of natural laws is startlingly at variance with the great strides which have been made in scientific knowledge; and the methods of teaching science and the little time devoted to it in the schools does not promise much improvement until present methods are radically revised." (Vice-president, ship building co.)

"In some way, if possible, the students who are to be favored with an engineering education should in advance have shown a natural talent or adaptability for such careers. The present haphazard way in which students take up engineering is a waste of time and money and results in many misfits."
(Member, engineering firm)

"The best training for a man with engineering tendency is an academic (so called) course followed by an engineering course. My general feeling is that the engineer should aspire to the management and control of industry and that his scheme of education should recognise this as a possibility and provide for it in his preparation for the profession." (Manufacturer)

"In Germany, specialization often centers about outstanding teachers or equipment. I think the time is ripe for five-year courses with specialization in the fifth year." (Research engineer)

"In general I believe (*a*) The student engineer should receive more cultural and inspirational training; (*b*) should specialize only in graduate work; (*c*) should spend more time in part time work in the industries." (Consulting engineer)

"I believe engineering education should be exceedingly thorough in the studies taken and in no sense a smattering. Many of the men who come to my office are not well prepared in any line, and have a smattering of so many subjects that they do not know any one well enough to use as a starter to build on." (Chief engineer)

"Successful engineering education depends primarily on advice with general supervision under the collective engineering judgment to be found in our national engineering societies."
(Assistant to president, manufacturing co.)

"I believe that quality in training is due more to character of instructing staff than to anything else. Men will grow men. Better teachers will produce better graduates and the curriculum should not be the dominating factor." (Vice-president, manufacturing co.)

"Engineering education should be linked up with engineering practice. College professors should devote some time to actual practice." (Superintendent)

"Would hope that a son of mine would spend a year between sophomore and junior years at work in industry to be able to appreciate 'what it's all about anyway' in the junior and senior years." (Plant engineer)

"It is well to bear in mind that the world's work is done by the mediocre, and it is he whom we have to take care of in educational matters. The genius will take care of himself." (Mechanical engineer, manufacturing co.)

PART VIII. MINERAL TECHNOLOGY

Scope of Inquiry.—The division of education commonly designated by the collective term "mining engineering" is actually a group of programs devoted to fairly distinct technical divisions of the mineral and metal industries, to which the term "mineral technology" is here applied. The breadth of the field, the large number of institutions offering training and the relatively small total enrollment of students give rise to peculiar educational problems which are reflected to some extent in the questionnaire.

Engineers Consulted.—Thirty-two fairly distinct fields of work are represented among the 177 engineers who answered the questionnaire. All but four received college training. Forty-five American institutions are represented, as well as a number in Europe. Sixteen types of college preparation are indicated, the group trained in mining engineering being in the lead with 38.8 per cent, with none of the other groups reaching eight per cent. Among the types of position held by the respondents, the industrial executives predominate with 39.4 per cent, consulting and chief engineers total 18.5 per cent, educators 10.5 per cent, geologists 7.9 per cent, and the remainder are engineers and metallurgists of various classifications. The leading elements in all branches and types of mineral technology are represented with the exception of ceramics and cement and glass technology.

Nature of Curricula in Mineral Technology.—The verdict of the group is consistently in favor of broad training, given in curricula which are only moderately differentiated from those in other branches of engineering. The group were asked to indicate a preference from four general plans of specialization as follows:

1. *"A single inclusive curriculum concerned only with the fundamental principles and methods of engineering as an introduction to mineral technology, to be followed by specialization in practice or in post-graduate study."*
2. *"A single basic curriculum for three years, followed by a group of options in such branches as metal mining, coal mining, metallurgy, petroleum technology, mining geology, and ceramics in a final year."*
3. *"A group of fairly distinct, complete curricula in the several branches of mineral technology."*
4. *"The first plan for the majority of institutions and plan number—for a few of the largest and most favorably situated institutions."*

The preferences indicated are shown graphically in Fig. 23.

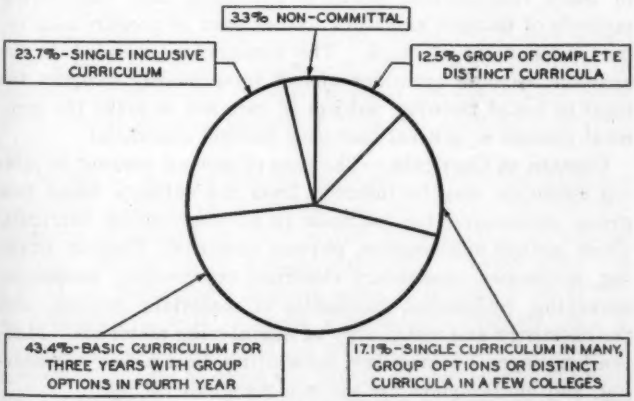
3.3% NON-COMMITTAL
23.7%-SINGLE INCLUSIVE CURRICULUM
12.5% GROUP OF COMPLETE DISTINCT CURRICULA
43.4%-BASIC CURRICULUM FOR THREE YEARS WITH GROUP OPTIONS IN FOURTH YEAR
17.1%-SINGLE CURRICULUM IN MANY, GROUP OPTIONS OR DISTINCT CURRICULA IN A FEW COLLEGES

FIG. 23. Preferences of mining engineers as to the general plan of curricula in mineral technology.

Those who favor some division of the curriculum, as suggested in the second and third plans stated above, were asked to indicate what subdivisions should be provided for and their choices are shown graphically in Fig. 24, both as percentages of the entire group and of the group who answered the specific question.

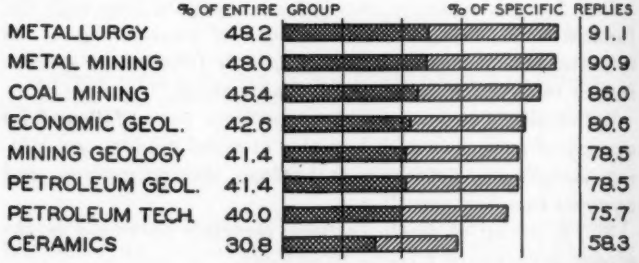

FIG. 24. Group options in divisions of mineral technology recommended by mining engineers.

By a ratio of three to one, the majority hold that the instruction in specific technical subjects should serve primarily to teach fundamental scientific principles and engineering methods of thought and work, rather than to prepare men for particular fields of work. The comments appended to the answers to these questions almost unanimously support the ideal of broad training, subject to care not to make the technical courses so general that they become superficial.

Content of Curricula.—The base of general content in mining curricula may be inferred from the subjects which this group recommend for inclusion in all engineering curricula. These include mathematics, physics, chemistry, English, drawing, mechanics, elementary electrical engineering, economics, surveying, hydraulics, mechanics of materials, geology, and the chemistry and metallurgy of engineering materials. Modern languages, business law, accounting, heat power engineering, and management are given a marginal rating.

A moderate majority express the opinion that students of mining engineering should receive specific training in the

realm of administration and management, and a considerable percentage would provide such training for all mining students. The plan most favored is that of a preponderantly technical course with electives in business subjects; a considerable number, however, would postpone this training until after graduation. In the wide range of opinions expressed through comments, the following may be taken as representative of the median and dominating position:

> "While many will never become administrators, it is important that all should be able to orient themselves to their organizational environment by understanding its nature."
>
> (Engineer, Bureau of Mines)

Both the formal and informal opinions of the mining group invest the economic aspects of engineering with great importance in the curriculum and subject matter. With few exceptions these engineers have not found the younger graduates well qualified to deal with the economic problems of engineering; they note considerable improvement among graduates of five years or more of experience, but still regard them as deficient on the economic side. Seventy per cent of those who suggest means of giving the proper economic content and emphasis favor greater emphasis on the economic aspects of the engineering subjects themselves; about one-fourth would seek a remedy through courses given by the department of general economics and an equal number through courses given by a special division concerned with the economics of engineering.

The use of modern foreign languages by mining engineers and their estimate of their value in the curriculum are particularly significant in view of the large amount of mining activity carried on in foreign countries. Nearly sixty per cent of the respondents indicate much or moderate use of foreign languages, with German, French, and Spanish used in fairly equal degrees. It is the majority opinion that modern foreign languages as generally taught to engineering students are not justified by their cultural value in proportion to the time expended. The comments indicate that mining engi-

TABLE II

Subjects Recommended for Inclusion in Curricula in Mineral Technology

(The results are expressed by the percentage of the whole number of specific replies which recommend the subject either for all curricula or for one or more curricula in the technical branches.)

	All Curricula	Mining	Metallurgy	Economic Geology	Petroleum Technology	Ceramics
Physical and Historical Geology	77.2	44.9	26.6	47.4	38.2	29.1
Field Geology	39.0	53.9	14.9	64.0	50.0	27.5
Geological Surveying	19.4	58.2	5.0	73.2	54.4	16.8
Economic Geology	55.0	56.6	21.8	57.5	42.4	27.4
Mineralogy	74.7	56.7	40.8	50.6	36.6	33.3
Petrography	40.8	44.9	25.8	61.5	33.3	24.9
Oil and Gas Geology	5.8	13.3	1.7	55.7	79.7	1.2
Petroleum Production	1.7	4.2	3.3	25.8	82.2	0.0
Petroleum Refining	0.8	0.8	3.3	5.8	78.0	0.0
Gas Engineering	5.8	8.3	39.8	5.0	74.8	18.2
Mine Surveying and Mapping	30.7	80.3	9.1	39.1	13.3	11.8
Mine Drawing	17.5	82.2	7.5	26.6	7.5	10.0
Mine Layout	11.7	86.5	5.0	12.6	2.5	7.5
Mine Structures and Timbering	10.0	86.5	3.3	7.5	0.0	3.3
Mining Machinery	13.3	84.1	7.5	6.6	0.8	4.1
Excavation, Boring and Tunnelling	17.7	84.9	3.3	17.5	15.8	8.3
Mine Ventilation and Drainage	10.8	87.5	1.6	3.3	2.5	4.1
Hoisting and Transportation	12.5	85.0	9.2	7.5	2.5	10.0
Metal Mining Methods	18.3	82.4	26.2	25.0	3.3	9.2
Coal Mining Methods	13.3	75.0	10.0	20.8	7.5	10.0
Mine Valuation	25.0	77.5	11.1	37.5	10.0	12.0
Mine Management	24.2	75.0	6.7	15.9	10.0	8.3
Mining Law	29.1	72.1	12.3	30.0	14,9	6.6
Sampling and Assaying	40.0	71.6	56.6	40.7	8.3	20.0
Ore and Coal Dressing	15.8	69.0	58.2	18.2	4.1	8.3
Metallurgy of Iron and Steel	28.3	27.5	82.2	8.3	5.8	5.8
Non-ferrous Metallurgy	19.1	28.3	79.8	10.0	3.3	14.2
Physical Metallurgy	12.3	15.8	81.6	5.8	1.6	6.6
Metallography	5.8	12.3	83.0	16.6	1.6	5.0
Metallurgical Calculations	12.3	20.0	83.0	4.2	4.1	12.3
Metallurgical Plant Design	5.0	11.8	86.0	4.1	3.3	13.3
Industrial Furnaces and Refractories	7.5	5.0	73.0	2.5	11.8	45.0
Pyrometry	7.5	6.8	79.0	5.0	11.8	45.0
Coking and By-Product Distillation	4.2	14.0	60.7	7.5	25.8	11.2
Properties and Preparation of Ceramic Materials	7.5	3.3	18.2	16.6	6.6	63.3
Ceramic Processes	0.8	0.0	6.8	4.2	0.0	69.0
Ceramic Calculations	0.0	0.8	2.5	4.1	0.0	70.8
Ceramic Design	0.0	0.0	1.6	3.3	0.0	69.6
Cement Technology	5.0	7.5	11.0	8.3	3 3	66.4
Glass Technology	1.7	0.8	6.6	6.6	0.8	74.8

neers, more than other groups, place the primary value upon ability to speak, rather than to read, foreign languages.

Technical Content of Curricula in Mineral Technology.—The range of technical subject matter in the broad field of mineral technology is so wide that selection is imperative. Engineers were asked to designate the subjects which are of such general importance as to warrant their *inclusion in all curricula in all branches* of mineral technology and those which should be *included in the curricula of the special branches* related to mining, metallurgy, economic geology, petroleum technology, and ceramics. The results are summarized in Table II.

The variety of the subjects of study included in the table is eloquent testimony to the difficulty of effectively organizing a system of training for the comprehensive field of mineral technology with an enrollment of students rather thinly distributed over a large group of institutions. The comparatively small number of subjects recommended for all of the technical branches in common emphasizes the difficulty in meeting the situation through a single basic curriculum extending through the entire undergraduate period. Outside of a few broad fundamentals a single curriculum would tend to become a compromise between rather slightly related elements, with the danger of being diffuse and superficial. From the fairly distinct nature of the group combinations advised under the several technical branches, it would seem that at least one year of differentiation within the field of mineral technology is fairly imperative, with separate group options in mining, metallurgy, petroleum technology, and economic geology. Ceramics has relatively few common elements and appears to merit a specialized curriculum in a few institutions where it can be adequately cultivated. Salvation for education in mineral technology appears to lie along the line of a considerable specialization by institutions, with a moderate number giving fairly general work in metal mining and metallurgy, and with relatively few emphasizing the other branches of the industry.

Influence of the Profession on Engineering Education.—The mining engineers, by a small majority, favor a larger influence on education by the national societies. There is little dissent, however, though many remain non-committal. The proposal to create a list of approved institutions brings a sharper alignment; the ratio of approval to opposition is practically five to four, or the lowest among the five groups.

General Comments by Mining Engineers.—The following have been selected as representative:

"The two important factors in education are first the boy, and second the teacher. The subjects themselves are secondary. A great teacher of the classics operating on the right kind of boy could produce a good mining engineer. We tend to overemphasize the subjects taught, as compared with the men who teach them, and the boy who is being taught.—The right boy can sometimes do wonders with very poor instruction and instructors, and a great teacher can sometimes do wonders with indifferent students."
(Superintendent and chief engineer)

"The members of our technical societies are best qualified to guide and foster our technical education along the right channels. The result of present educational methods and standards is far from satisfactory. Why is it necessary for our engineers of today to begin their life work by trying to 'forget all they ever learned in college?'" (Chief engineer, zinc co.)

"While the tendency today in engineering practise is toward specialization and while this must inevitably increase, I believe that the educational period of an engineer's life should be as broadly general as possible within the limits of a reasonable specialization, such as mining, electricity, chemistry, civil and mechanical engineering." (Consulting engineer)

"A group of students resembles a miscellaneous collection of larvae, 10% of butterflies and 10% of beetles. Each of the latter is destined to bore a hole into a nut and to feed there until he dies, but the former become engineering butterflies. For whom then is the education designed? The butterflies or the beetles?"
(Engineer, Bureau of Mines)

"The economic value of engineering should be stressed at every turn. The engineer must know more about business in order to protect his own interests and help sell his services at a fair price, —which the majority are not doing now." (Mining engineer)

"The basis for success in higher education is to be found in better primary education. The colleges cannot graduate city men for the coal mines. They must take the men from the coal mining field and these are hampered by the poor schools and poor teachers in the coal mining communities." (Editor)

"This is called Specialist's Age. Most engineering graduates know too little about too much and have not had the power to think drilled into them. There is too wide a difference in men from dif-

ferent schools. In general the small technical school men take hold with better intelligence." (Superintendent and metallurgist)

"Deem it advisable to thoroughly train in the fundamentals. Business knowledge and judgment are gained from active experience under 'fire.' Cannot make a finished technologist in college atmosphere. Harmful when tried as student gets a wrong perspective of himself in relation to actual industrial pursuits."
(Vice-president and consultant)

"(*a*) A rigorous and thorough training in fundamentals should characterize the engineering course. (*b*) Specialization should be reserved for graduate courses. (*c*) Plant practice should be studied in the field." (General manager)

"I am convinced that the engineering profession should exercise a much more direct influence on engineering education. I am inclined to think that a national body should be formed for this particular purpose, with members to be elected by the several national societies." (Vice-president and general manager)

"In brief, my criticism was: too great detail in some branches, and too little general education; too much mathematical grind, too little of the humanities; too little economic geology from the broader point of view, too much intricate differentiation of rock technicalities; too little on the side of business management, personnel and economics; too sharp specialization before students are prepared to receive it or to know what it all means."
(Consulting mining engineer)

"Two of the more important basically wrong factors which are quite obvious are the facts that our output of 'engineers' is at once much too large and of very indifferent quality and second that the returns, financial and otherwise, from teaching are not such as to attract some who would be most valuable in such capacity."
(Consulting engineer)

"If the instructors in our schools can be made to see that teaching is their most important function and be induced to claim and give each other credit for success in teaching, the whole subject will be much simplified. A very large proportion of our instructors apparently believe that only research work should be considered. Fundamental research work is of the greatest value and importance but very few men are capable of doing it and still fewer are capable of teaching at the same time. Much of the so-called research work is trying to devise new processes by men who do not know fundamental economic conditions by which they can be judged." (Editor)

NOTES ON THE WORK OF THE BOARD AND STAFF.

BY W. E. WICKENDEN,
Director of Investigation.

The following notes will serve to indicate the character of the work in progress under the auspices of the Board of Investigation and Coordination.

Summer Schools.—Accounts of the schools of 1927 have been published in the JOURNAL for September. Mr. Hammond is preparing a more extended record of the two schools in the form of a bulletin and will have the first half ready for publication in the January number of the JOURNAL. Meanwhile, special funds are being sought and preliminary preparations made for two schools in 1928, one for teachers of physics and one for teachers of electrical engineering. One member of the Society has already made a cash subscription and there are other hopeful prospects.

Educational Guidance.—The writer has completed the manuscript of the division on engineering education in a volume entitled "Units of Higher Education," which is being prepared under an editorial board as a text for use in the colleges of education. Mr. Hammond has done considerable preliminary work on a bulletin to present the opportunities and requirements of the engineering field to teachers of occupations and counsellors in secondary schools.

Publications in Preparation and Projected.—Mr. Hammond has carried the preparation of the bulletin on placement examinations and selective sectioning to the point where it may be completed after conference with Dr. Stoddard, of the University of Iowa, during the Christmas holidays. The writer has reduced the material for the bulletin on the studies of engineering education in Europe to systematic notes, which need only to be woven together into an orderly exposition and interpretation. The Staff has under consideration the preparation of a bulletin to bring together all available material on

the occupational demand in engineering education. Decision will await the appearance of the final report of the investigation by the National Industrial Conference Board and conference with other agencies which may be able to supply information. The Staff is projecting a complete summary report of the entire investigation under the Carnegie Grants, to be presented to the Society at its annual meeting in 1928.

Cooperation with Engineering Societies.—The bulletin on the inquiries by the five national engineering societies has been completed and appears in the present number of the JOURNAL. The writer is preparing a report to the national societies, to be considered by their counsellors, proposing definite measures of collaboration with this Society, to put into effect the policies and measures indicated by these inquiries, and to create a basis for the permanent liaison contemplated in the report of the Committee on Policy, as adopted at the Orono meeting. The writer addressed the annual meeting of the American Society of Mechanical Engineers on December 6, 1927, on the subject, "What the National Engineering Societies Can Do for Engineering Education."

Collateral Investigations.—Announcement is made elsewhere in this issue of a special fund which has been provided for an inquiry in a field which parallels the investigation already made by the engineering colleges. The preliminary plans, which led to the grant of funds, were prepared by the Staff. An advisory committee is now being formed, and a special field representative sought to aid in the conduct of the inquiry. Proposals have been made by the writer to one of the national engineering societies looking toward an inquiry into the present state of training for specific trades, crafts and industrial processes, and for first line supervision, in one of the principal mechanical industries. It is not intended that the Board will take active charge of this latter investigation, if it is authorized, but that it will provide a certain measure of assistance and coordination.

New Projects.—Mr. Hammond is promoting a project for an experimental trial of comprehensive examinations for

seniors. The general field of electrical engineering has been selected for trial and preliminary work is being done with the cooperation of Dr. L. J. O'Rourke of the U. S. Civil Service Commission, Mr. H. H. Henline of the A. I. E. E., and Mr. R. E. Doherty of the General Electric Company. The writer is at work on proposals for a group of projects, looking to improvements in the teaching of the economic and societal subjects of engineering curricula, with the cooperation of Prof. Leon C. Marshall of the University of Chicago, Prof. H. G. Pearson of M. I. T., and others. A project for the cooperation of the editors of a group of leading engineering periodicals in the preparation of case-books, to supply teaching materials in the realm of engineering economy, has been initiated.

Foundation for Engineering Education.—On recommendation of the Committee on Policy, the Council has authorized that steps be taken to establish a Foundation for Engineering Education as an auxiliary to the Society, to receive and hold trust funds for the permanent support of activities which have been instituted on an interim basis under the present Board. The writer has prepared an extended prospectus of the proposed Foundation for the Ways and Means Committee. An active campaign for an initial endowment to yield an annual income of $50,000 is about to be undertaken.

Addresses and Conferences.—The writer gave the opening address at Case School of Applied Science and met the faculty in conference. On November 11 he addressed the Association of American Universities on the subject, "A Policy for Engineering Education." On November 15 he presented the same subject at the annual meeting of the Association of State Universities. The writer spoke at a largely attended general session of the Association of Land-Grant Colleges and Universities on "The Survey of Engineering Education." At the fall meeting of the New England Section of the Society, Chairman C. F. Scott and the writer introduced the discussion of the theme, "Now that we have the report of the Board of Investigation, what are we going to do about it?" Mr. Hammond addressed the gathering on "A Practical Step To-

ward Improving Methods of Teaching." At the fall meeting of the New York-New Jersey Section, Mr. Hammond again presented the work and results of the summer schools and the writer was one of three speakers on "Opportunities in the Metropolitan District for the Extension of Engineering Education."

The writer is organizing a half-day program on the relations of the engineering colleges and the technical high schools, at a national convention of principals of the latter institutions to be held December 30 and 31, 1927, which is being arranged on the initiative of Mr. Albert L. Colston, Principal of the Brooklyn Technical High School, and a member of the Society.

Other Activities.—Chairman C. F. Scott is a member of the advisory committee on a special investigation of the teaching of economics in various higher institutions which is being conducted by the National Electric Light Association. Dean Anson Marston is also a member of this committee. The writer is in contact on specific matters with Dean C. O. Ruggles of Ohio State University, who is in active charge of the survey. The writer is serving for one year as a member of the Administrative Board of the Personnel Research Federation. He is also serving on the preliminary committee on American participation in the World Congress of Engineers, to be held in Tokyo in 1929. At the suggestion of President Sackett, the writer is preparing a memorandum on the scope and activities of the institutional division of the Society.

COOPERATIVE COURSES AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.*

BY W. H. TIMBIE,

Professor of Electrical Engineering and Industrial Practice.

The introduction of the Cooperative Course in Electrical Engineering at the Massachusetts Institute of Technology is an example of how this educational scheme can successfully be adapted to the ideals, standards and traditions of an old established institution. Naturally, with such a background of educational ideals and traditions a number of departures from the usual practice in cooperative courses has been made. The course represents an effort to get the maximum benefit from the recognized advantages of the cooperative method, without including those features which are of questionable value, or which are inconsistent with the educational ideals of the Institute. The object of this paper is to point out what variations of the usual practice have been introduced, and to show that in each case the underlying reason for introducing them was educational and not a question of convenience of schedule and administration.

In the first place it should be definitely understood that the cooperative course had to satisfy, and does satisfy, all the rigorous scholastic requirements for the degree of Master of Science in Electrical Engineering, as laid down for every student who desires this degree from the Massachusetts Institute of Technology. This rigid specification for definite scholastic attainment forms the very educational foundation upon which the cooperative course has been built. Every detail of the plan has been worked out in accord with this specification. No variation which was not in strict harmony with it was given any consideration.

* Presented at the 35th annual meeting of the Society at the University of Maine, June 27–30, 1927.

The Basic Educational Principle.—It is a firmly grounded and well-substantiated belief at the Massachusetts Institute of Technology that the students' time can best be spent on the study of the fundamental theories of science and that it is a flagrant waste of both time and money to try to teach engineering practice at the Institute. The student comes to the Institute, we believe, in order to get a firm foundation in theory and science, because ordinarily, he cannot obtain this on the job. The place to learn theory is in school, the place to obtain practice is in the industry. Consequently the regular course in electrical engineering, in strict accord with this belief, consists almost entirely of the fundamental facts and theories of science, and relates these to practice through examples of application.

Engineering Practice Does Not Take the Place of Theoretical Training.—Now we believe that engineering practice is just as important as theoretical knowledge and science, but, in our estimation, engineering practice must be given in addition to theory, not in place of it. So, in laying out the cooperative course in electrical engineering not one hour of the theoretical content of the regular course has been sacrificed. The cooperative student receives exactly the same undergraduate instruction as the non-cooperative student, with the exception of a few hours in the shops and drafting room. Not one hour of instruction in science, mathematics or economics has been replaced by the practical work in the industries. Furthermore, instruction in the cooperative course has not been condensed or concentrated in any way. The cooperative student carries the same number of hours a week as the regular student—no more, no less—and works the same number of weeks in the term. We believe it to be just as fundamental that a student should cover the ground at the proper rate as that he should cover the proper amount of ground. We are much more interested in the quality of the work which a student does than in the quantity. Therefore, if the schedule of the regular student in electrical engineering represents the optimum of quality and quantity, then necessarily the same

schedule should be maintained for the cooperative student. Thus, a student in the cooperative course at the Massachusetts Institute of Technology takes exactly the same academic work as the non-cooperative student, and takes it at the same rate.

But the cooperative course is more than an undergraduate course. It is of five years' duration, two years in the regular schedule and three years on the cooperative schedule. For its successful completion a degree of Master of Science is granted in Electrical Engineering. Accordingly, a full year of post-graduate instruction and study is added to the four years undergraduate work. The same graduate requirements are imposed upon the cooperative student as upon the regular student. He must successfully complete 1440 hours of graduate work of recognized grade equivalent to from 36 to 40 semester hours. Not one hour of academic credit, graduate or undergraduate, is given to the cooperative man for 78 weeks experience in engineering practice with the companies. In order to receive degrees in this course the student must earn full credit in both theory and practice.

Cooperating Periods Full Term in Length.—The reason for choosing a term as the length of the cooperative period was strictly educational and not a matter of convenience. The two principal reasons may be stated as follows: (1) periods of a term's length enable the student to complete the regular units of study without interruption; (2) the student can enter the campus life and student activities to the fullest degree.

Taking up the latter reason first; whatever the Faculty may believe concerning the value of campus activities, certainly the students themselves believe most firmly in them and are loath to take a course the schedule of which forces them to forego the social opportunities of the campus and of the various student activities. That this is not merely a theoretical consideration is shown by the fact that the students really take advantage of this arrangement of the schedule. Cooperative students at the Massachusetts Institute of Technology have been represented on practically every athletic team, including several winning crews, and have acted as

managers and assistant managers of many of the major teams and publications. A year ago the leader of the Glee Club was a Cooperative Student. They have taken part in the annual Tech Show, which is the most comprehensive student undertaking at the Institute. Each year a complete show, written by a Tech student, in which all the actors, musicians and managers are Tech students, is put on for several nights at a Boston theater and makes a trip to New York, Pittsburg and other eastern cities. Each year there has been a number of cooperative students in the cast, and for two years the leading man was a cooperative student. The position of the greatest student responsibility is that of Senior Class President, who is also Chairman of the Institute Committee, a body representing every important student activity at the Institute. This position has been held with marked success by a cooperative student. Surely, the cooperative students make good use of the opportunities offered by the term-length period to enter into the student life of the Institute.

Class Sessions Held at the Works.—Going back to the first reason for the term length period: it should be stated that not only does this length of term enable the student to complete regular units of study without interruption, but it also provides opportunity for organized instruction in Institute subjects while the students are at the plants of the cooperative companies. As a matter of fact, two regular Institute studies are carried on by the students while they are away from Cambridge. Class sessions are held two evenings a week, one session in electrical engineering, the other in a so-called humanistic subject. To carry on this instruction members of the Institute instructing staff are located permanently at Pittsfield, Massachusetts, Schenectady, N. Y., and New York City. The underlying educational reasons for putting in these classes are two. First, to prevent any hiatus in the students' study habits. Second, to offset any real or imagined coarsening or materialistic tendency which some have supposed is prevalent in the modern industrial world. Whether or not

the credit can be given to the humanistic studies, eight years experience has shown that industrial contact has not coarsened the cooperative men, nor has it made them noticeably materialistic. It may be stated in this connection, however, that the work done in the humanistic studies has been particularly notable, in fact all the classes have proved more successful even than we had hoped. In many cases better work is being done in the same subjects when presented at the works than when given at the Institute. This is due to a number of causes. In the case of English, the students naturally find many subjects of interest during their practical work, so that they always have a plethora of live material to talk about and to write about. We find the engineering student as willing to talk and to write as any other student, if he is allowed to talk or to write about subjects in which he is interested. Then, too, the student's attention is concentrated on two subjects only while he is at the plants. Naturally, he would do better under this condition than when his attention is divided among several subjects, as it necessarily is when he is at the Institute.

These classes at the plants have also been successful in continuing the student's habits of study and maintaining his mental alertness. One of the by-products of these classes has been the development in young engineers of the habit of studying several evenings a week when they are employed during the day. Employers of the graduates of this course report that this habit is, apparently, as hard to break as it is to form, and that the men go right on with their evening study after graduation. This result alone makes it worth while to maintain this feature of the cooperative work. The success of the young engineer depends just as much upon keeping up his habits of study and research as it does upon how well he carries on his daily tasks. The student who closes his textbooks on graduation day is very likely at the same time to close his mind to study and his eyes to opportunity.

Another result of carrying a light study schedule during the

cooperative period is that there is practically no slack in changing from school to plant and back to school again; in fact, there is very noticeably less lost motion than there is between two school periods separated by a vacation. And theoretically this should be so. It has been fairly well proven by experience that one of the best systems for keeping physically fit is to alternate periods of intense exercise with periods of light exercise, rather than to maintain periods of intense exercise separated by shorter periods of complete rest. The term-length schedule operated in this way is thus in accord with the best theory and practice for keeping a man fit, mentally and physically.

Practical Experience Laid Out in the Form of a Course.—Another unique feature of this cooperative plan is the arrangement of the practical experience into a definite course. The men are not given just a series of jobs, but are put through a carefully planned and supervised course of practical experience. The basis for laying out the student's course in practical experience is not primarily the plant convenience of the cooperating company, but the educational value of each operation, the test question in each case being: "Does this work offer the greatest educational opportunity to the student?" The term, educational opportunity, includes two features: (1) The work should be of such a nature that it will show the student how operations are planned and carried out in actual practice in that particular part of the electrical field in which he wishes to make a place for himself. (2) A job may have for its primary object a vocational guidance value; that is, it may be given to the student in order to acquaint him with some part of the electrical field other than the one in which he is at present particularly interested. An example of a job combining both of these features is the construction work which the men take in the Stone & Webster Option. A student is not sent out on a construction job primarily to become skilled as a workman, but to get the atmosphere of the construction camp and to learn under what conditions the actual building of a power plant must

be carried on. Very few of these students have any idea of becoming construction engineers, but once in a while the possibilities of this end of the work so appeal to one that he enters his life's work through that channel. The main purpose of this work, however, is to teach the men just what one student wrote on his report: "I have learned how much more difficult it is to make a bend in an iron conduit on the job than it is on the drafting board."

Rate of Pay.—One of the natural consequences of laying out a course of experience on an educational basis is that the rate of pay cannot be made to depend upon the skill which the student acquires in any particular department. Some other basis of payment, therefore, must be used. The Massachusetts Institute of Technology plan makes a man's rate of pay depend upon what class he is registered in at the Institute. Thus, all the juniors receive one rate of pay; the seniors all receive a higher rate and the graduate students the highest rate of pay. Students in any one class all receive the same rate of pay. While the student's remuneration does not depend upon the quantity or quality of his production, he is expected to do his full part in production and his rating in Engineering Practice for the term depends upon these factors. The student, therefore, is working for a good rating with the company, rather than for a higher rate of pay. This arrangement safeguards the plan against the student's trying to earn more money by remaining in a department longer than it would be educationally profitable.

Another safeguard has been put in by most of the companies. The time of the students is charged against a special account, rather than to the department in which the student is working. This removes the temptation for the head of any department to try to keep the students beyond the allotted time, in order to obtain skilled labor at a low rate. The foreman cannot complain that a student is moved as soon as he becomes useful to the department, if the student's pay is not charged against the department, and the foremen generally welcome the assignment of students to their work.

Why a Student Takes All His Practical Work with One Company.—In this course a student takes all his cooperative work with one company. Since there are five companies cooperating, each representing a particular branch of the electrical industry, there is an opportunity for each student to apply to that company which offers the kind of experience which he desires.

The General Electric Company affords a comprehensive course in manufacturing practice, including the development, design, manufacture and test of a diversity of electrical and mechanical products, varying from meters, vacuum tubes and small motors to large transformers, generators, steam turbines and electric locomotives. In obtaining this experience, the students may work in any of the four principal plants of the company, at Lynn, Pittsfield, Schenectady or Erie.

The Edison Electric Illuminating Company of Boston affords an equally comprehensive experience in public utility practice in the operation of a thoroughly modern property for generating and distributing electricity for light and power. The experience ranges from work in installation and maintenance of transmission lines, meters and other equipment, and steam engine and generator operation, to work in the supply and sales departments, electrical engineering offices and standardizing and testing laboratories. This company won the Charles A. Coffin Medal for 1927. This is a gold medal awarded annually to the public utility operating company within the United States which, during the year, has made the greatest contribution towards increasing the advantages of the use of electric light and power for the convenience and well-being of the public and the benefit of the industry.

The Boston Elevated Railway affords unusual opportunity for experience in the operation of urban and interurban railways. The student gets experience as Repairman, Motorman, Conductor and Inspector, as well as work in the engineering offices and time-table and traffic divisions. The last five weeks of the course are spent in the General Manager's office.

Stone & Webster Incorporated affords an unusually complete course of experience in designing, constructing and operating both steam and hydraulic projects. Here, a student has practical experience in electric, steel, concrete and architectural drafting, the surveying, construction and installation connected with some power project, and he has actual operating practice in gas plants and electric plants. In the statistical department he analyses and tabulates data on the cost of the construction and operation of a large number of different properties.

The Bell Telephone System affords a comprehensive experience in communication practice, giving the students experience in the manufacture of communication equipment in the Western Electric Company's plant at Kearny, New Jersey; experience in installation, operation and testing of switchboards, station and line equipment with the New York Telephone Company, and in the development and design of apparatus and circuits for wire and radio communication in the Bell Telephone Laboratories in New York City.

While, as may be seen from the above, the student has a wide range of choice as to just what particular field he wishes to obtain his practice in, since his choice places him with one of the cooperating companies, the course of undergraduate study at the Institute is substantially the same for all the cooperative students. The specialization is in the engineering practice and in the graduate work. Both the Institute authorities and the company officials believe that this is the ideal arrangement.

The growth and stability of modern business depends fully as much upon the loyalty and teamwork of the engineers and executives as it does upon their individual attainments and brilliancy. Thus, while the school training should develop in the highest degree the mental and personal capacities of each student, it must also give him a training in the important virtues of loyalty and cooperation. It is for this reason that the practical experience of any one student is gained entirely in the plants of one of the cooperating companies. He does

not move from company to company during his training period. This enables him to get a unified conception of the company's policy and to become imbued with the spirit of loyalty, which is so much in evidence in every successful organization of the present day. His three years' contact with one company teaches him that loyalty and enthusiasm are prime requisites for his success and advancement. He sees that the disgruntled and complaining employees remain at the bottom. The higher a man rises in the service of the company, the more enthusiastic he is, and the greater his loyalty to his firm. The student soon finds that the truth of the matter is that a man is not disgruntled because he is at the bottom, but that he remains at the bottom of the ladder because he is disgruntled and disloyal. He learns that the big question is not "What is there in it for me?" but "How can I be of the most service in putting the work through?" The use of the pronoun "I" becomes less and less frequent, and the pronoun "we" comes more and more into his thinking and talking.

The second reason for confining the students' practical experience to the plants of one company is in order that definite provision may be made to prevent loss of time due to fluctuations in business conditions. The course operates under agreement with each company to give each student who starts in with the company and who continues to do satisfactory work a definite course in engineering practice, which, although it may have to be slightly modified, will not be interrupted by business conditions. The course has already weathered the great business depression following the war. The modification that was necessary consisted, in the main, of merely a change in the order in which the work was given, since certain portions of the plants were temporarily unable to use the students to their maximum advantage. Not a single student was laid off, although in some cases the number of hours per week was decreased from 48 to 40 for a few weeks.

Course Through Works One of Real Advancement in Responsibility.—The fundamental principle that the experience be laid out in a definite course also makes it almost imperative

that a student take his work with one company. In changing from one company to another it is almost necessary for a student to suffer demotion rather than to progress. In the Massachusetts Institute of Technology plan the cooperative student always progresses to more and more advanced work, so that the assignments in the latter part of his course are work of a real advanced character, such as research, creative design, or inspection and production studies. It is one of the big advantages of the cooperative method of training that the student in no place in his career suffers the demotion that the average student of an engineering school has to experience upon taking his first job, after spending four years in work requiring a high grade of mental activity. So in the Massachusetts Institute of Technology course this advantage is maintained throughout by arranging a progressive course of experience within the plants of one cooperating company.

This demotion, which nearly every graduate of a four-year or five-year course in engineering suffers when he enters the industry, is so apparent and so serious that it is usually given as one of the primary causes of the difficulty which industry has in assimilating the young graduates from the engineering schools of the country. The test courses and training courses which a number of large companies have put into operation have, in the case of these companies, somewhat alleviated this condition, but still we hear the employer on every side saying, "I don't want a college man until he has been out of college for three or four years. He is worse than no good. He is a disrupting influence in my organization."

A study of the character of permanent employment which the young graduates of this cooperative course secure upon their graduation is perhaps the best evidence that this type of cooperative plan practically eliminates demotion upon graduation. We believe the progressive nature of the practical assignments produces this result. The young graduate's job is merely an assignment to a job of a still more advanced character. Thus, a list of the employments to which the last year's graduates went shows that, out of 39 graduates, 28 went

immediately to positions requiring no student or cadet course with the company. These positions are mostly Assistants to Production Managers, Assistant Designing Engineers, Assistant Sales Engineers and Assistant Operating Engineers. Six entered upon advanced specialized training with the cooperating companies and three of the class continued their studies towards a Doctor's degree. Even the men going with the companies in an entirely different field from the one in which they took their training suffered little or no demotion. But the cooperative plan has produced an even more important result for its graduates than merely to wipe out the demotion at graduation. It has materially accelerated their rate of advancement in industry. A recent study was made of the salaries received by the graduates of this course. Data were received from 133 out of the 147 men (90 per cent of the total number of graduates). These cooperative graduates were compared with graduates from non-cooperative courses, who, in each case, class for class, had been out one year longer. The study showed that the average slope of the salary curve of the median man in this group is 55 per cent greater than the average slope of the median man of the graduates in the corresponding years from the engineering colleges throughout the United States, as reported by the JOURNAL OF ENGINEERING EDUCATION of June 1926. The information concerning the salaries, together with that concerning the real responsibility attached to the positions held by these men, is a fair indication of the soundness of the educational system under which they receive their scholastic and practical training.

Cooperative Students a Selected Group.—The fact that the graduates of this course are unusually successful is sometimes explained by stating that since they are a group selected for good scholarship, sound character and attractive personality, of course they will be unusually successful. I do not believe that this is by any means the full explanation.

It is true that to be accepted for this course a student must not only meet the rigid scholastic specifications stated above, but he must also possess personal characteristics which make

him a desirable candidate for permanent employment with the cooperating company. This results in the course being a sort of reward of merit for attainment in character and personality as well as for scholastic excellence.

This selective character of the course has two purposes:

First: In the cooperative schedule there are no long vacations. The student is either at the Institute or in the plants of the cooperating company for eleven months during each of the last three years. He has little or no time to make up scholastic failures. It is almost necessary therefore to grant the privilege of this course to those men only who have shown themselves capable of handling our regular schedule, without the necessity of repeating courses.

Second: This is a graduate as well as an undergraduate course. Each man chosen must show indications that he possesses the ability and character to carry on graduate work of a distinctly advanced grade over that comprising the undergraduate part of the course. He must be Master-of-Science material.

The careful selection contributes, of course, to the success of the graduates as a group, but it can by no means be given the full credit. The members of Eta Kappa Nu, the honorary electrical engineering society, are chosen for the same qualities, high scholarship, sound character and attractive personality. Yet the published reports of this society concerning its own graduates for the same years mentioned in the above study show a slope in the salary curve of the average man which is no steeper than that for the median engineering graduate for the country at large.

This being the fact, I believe it to be much fairer to attribute the rapid rise of the cooperative students in both responsibility and salary to the happy combination of a careful method of selection and a superior scheme of education.

In the preceding paragraphs, I have shown how a cooperative course can be introduced into an old well-established educational institution without any lowering of educational ideals and with but very little change in the schedule of ac-

ademic studies. To be sure the course differs in many details from the majority of cooperative courses in other institutions, but each departure from the general practice of other courses has been made, not to meet some convenience of schedule, but in order to adhere to the rigorous scholastic specifications and the high standards of science of which the Institute is justly proud.

Discussion.

F. E. Ayer: Honorable Judge, Gentlemen of the Jury: I hereby solemnly swear that this confession which I am about to make is made of my own free will and accord, with the full realization that anything which I say may, and probably will, be used against me. I am surprised to see that so many of you are acquainted with that procedure.

I am not going to discuss Professor Timbie's paper alone. I am going to discuss for a few moments this whole idea of cooperative education. I think the program committee made a mistake in putting cooperative education on this program at all and surely in calling upon me to discuss it. I have been adjured by my friends by all means to refrain from anything of a controversial nature. In this connection, there were a couple of colored boys having a conversation like this:

One of them said, "Sambo, you certainly are looking bad this morning."

"Oh," he says, "I'se sick."

"Well," said the other fellow, "if you all are sick, why don't you go to a doctor?"

"I did go to a doctor."

"Did you do what he said?"

"No, I didn't. He said, 'You take one pill three times a day.' Now there ain't nobody can do that."

And so, to try to discuss this cooperative education question at an S. P. E. E. meeting without controversy is like asking Nicholas M. Butler and Calvin Coolidge to discuss the wet and dry question without anything controversial creeping in.

If there is any apology necessary for the incident which I

related, it is simply that throughout the whole discussion during this Convention there has been such a plethora of boisterous levity, that it is time a serious note was sounded in the discussion. And so I want to take up for just a few moments this report of the Committee on Cooperative Education and the objections which we who are operating cooperative courses have to this report.

In the first place, you will remember that the Board of Investigation decided that the investigation of engineering education should be an investigation from within, that we should be competent to investigate ourselves and find out what is wrong, if anything. That has been carried out up to the point of the investigation of cooperative education and that committee did not have upon it anyone who is operating a cooperative course.

Now our objection is that if the first method was the correct method for all the rest of the investigation of engineering education, then it should have been the correct one for the investigation of cooperative education. Whether that method of investigation is the correct one or not, there may be a question. At any rate, it is not unique. It has been practiced in the United States Senate for years. I am sure that if we had had ten or twenty thousand dollars for three or four years and the colleges operating cooperative courses had conducted this investigation themselves, we should have had an equally laudatory report.

Then another thing that we have heard a great deal about even in this meeting is the engineering method. The Director of your Investigating Committee told us the other day that Herbert Hoover was not only a great engineer because he knew mining engineering but because also he was able to use engineering methods in applying it to different lines of work.

We do not believe that if you were going to investigate a new type of bridge design that you would send out a lot of electrical engineers; you would try to get somebody on that committee who had had something to do sometime with the designing of bridges. We believe this investigation would have given a better idea to the public at large if there had

been at least one or two on that committee who were engaged in the operation of cooperative courses.

Further, in regard to that engineering method, we are taught as engineers that we must learn all that we can about failures. If a structure is designed and built and then fails, it is at once very necessary that the engineers investigate and find if possible the cause of that failure in order to prevent such a thing in the future. We have in this report two colleges listed as having started the cooperative course and given it up, namely, Harvard and my own alma mater Lafayette, and the only explanation given in the report is the explanation which comes from those colleges themselves. We believe that had that question been asked to almost any one of the men operating cooperative courses or certainly asked of a committee of those men, they could have given some very good reasons why those courses were abandoned in those institutions.

Now just a word as to the report itself. I am personally acquainted with the members of the Committee that made this investigation and they are certainly estimable educators and gentlemen in every sense of the word, and their collection of fact is something which cannot be criticized by anyone. It is a fine report, they have done a great piece of work, we all appreciate it. When it comes to the interpretation of the fact, there again we believe that this presentation would have been better if there had been some members on the Committee who were actually engaged in operating cooperative courses. Just a few instances to illustrate what I mean:

On page thirty-five of the report, headed "Analysis of Opinions Relative to Cooperative Training," we have first the source of the opinions and then down about in the middle of the page, "It proved to be difficult to obtain the views of those likely to hold a more impartial viewpoint as completely or systematically as was needed to give a balanced summary."

I was talking with Dean Schneider last week about that and he said that he was asked to give the names of firms who were not favorable toward cooperative courses, and he and his co-

ordination department were put to some trouble to find three such firms, while the three firms who were for it were selected from a group of three hundred firms but in this paralleling of the arguments, we would naturally infer (unless we were told to the contrary), that the arguments in each column were to be given the same weight. It does not seem to me that the arguments for, coming from a group of three hundred satisfied manufacturers, and those against, coming from a group of three manufacturers ought to have the same weight.

Furthermore, there is no way for the average reader to know which of these opinions, for or against, come from people who are actually operating cooperative courses and which come from those who have operated in the past and are not operating now, or come from those who never operated them at all. That is a thing which we ought to know if we are going to weigh the arguments one against the other.

Then, I have some criticism to make of the logic in some cases. I probably will be wrong in my criticism, but I offer it as an interesting error, at least. If we turn to page forty of the report, "Advantages to the Institution and Faculty," we have under the side of for, "with given facilities and staff, more students can be accommodated, the cost per student is thus reduced, etc.," and as an argument against that, "if students take the same number of hours of instruction in sections of the same size and if the teachers carry the same teaching loads, the cost of instruction will not be different in the two cases."

That, of course, is absolutely true. No one could take any exception to it, but right on the same page, when we come to another phase of it, we find this quotation: "The statements of teachers indicate that the intensive nature of cooperative courses as practiced, places increased burdens on the faculty," and that, "this is one of the serious disadvantages of the plan."

Now I do not know anything about logic, but I have studied plane geometry. I was taught that if we assume a circle in the beginning of the proof, we should not make it in an

ellipse before we get to the end. In the first part of this we assume that if every thing is the same as it is in the four-year course, then certain things will prevail or follow, then when we get in the next paragraph, we assume that such is not the case. That does not seem to be good logic to me. Another case similar to it we find on page fifty, under "Educational Merits." This is not the parallel column part of the report. "On the one hand, there is no proof that the effort to co-ordinate industrial experience with instruction received in college results in greater learning efficiency or a better grasp of fundamental principles." Then, on the same page in the paragraph headed "Character Development," it says, "In a word, the cooperative system provides a steadying influence which tends to mature the student. Some *may* feel that this is not wholly desirable. The college student is likely to be something of an idealist and to have a rather well-developed sense of altruism. This attitude towards life, if properly fostered in college, is likely to carry over into the years of maturity and leave a wholesome residuum to act as a balance to the sophistication of later life. The cooperative plan which advances the time of entry into the competitive atmosphere of industrial experience, *may* hasten the process of converting the idealist into the realist." (Italicization by the speaker.)

In the one paragraph, those who are for cooperative courses can furnish no proof that certain conditions exist; in the next paragraph, those who are criticizing it are not required to furnish any.

It is a pretty well established principle of law that the prisoner is to be considered innocent until he is proven guilty. This burden of proof ought to rest on the other side and as another example of that same thing, you will find in this parallelism a number of cases like this, on page thirty-eight, under the argument for the plan, "The student observes and learns up-to-date shop practice and engineering methods." Then in the column against the plan, "Possibly he does. Does he, however, learn fundamental principles as well?" Now if you are going to interject questions, why not interject them on the other side?

You will find if you look through the report, a number of cases of that sort of parallelism which does not seem to me to be entirely fair. Under advantages to industry, "An opportunity is afforded to try out the students, to observe their ability and traits of character, and to choose those of greatest prominence." And opposite: "This may be true, but is it always for the student's best interest? Is there not danger that the organization may exploit the students to its own advantage?" This last is not the opinion of anybody, except perhaps the one who wrote the report. And just a word about that particular thing, what difference does it make whether this student is exploited before he graduates or after? There is this advantage in the cooperative method, that the coordination department has a hold upon that student for one year longer than it does under the resident system and can probably keep him from being exploited to much better advantage.

One great advantage as we see it of the cooperative system, is the bettering of the relations between engineering teachers and industrial employers. The big objection that was made by educators when the cooperative course was first talked about, was "Why, those industrial leaders are just going to exploit those boys the minute they get hold of them." And most industrial leaders said, "What does a highbrow college professor know about training a boy for industry, anyhow?" The cooperative system has proved the fact that so-called highbrow educators do know how to train men for industry, and it is also proved that employers do not exploit these students.

In the twenty-one years of the existence of this course in the University of Cincinnati, Dean Schneider told me last week he could recall only four cases where they were obliged to take students out of the firm because the employer was not treating them right. We have found the employers are fair.

I have just one other thing to which I should like to call attention. On page fifty-three, we find this statement: "Under causes of growth of the cooperative plan," the statement is

made: "It will probably be seriously questioned whether much of the growth of the cooperative plan has not been due to its attractiveness in reducing the investment in facilities and providing for the self-supporting students rather than its fundamental educational merit. To institutions considering the establishment of engineering courses or already providing such courses without adequate resources, the cooperative plan seems to offer not only the means of reducing initial outlay but also of insuring a student body and of increasing the revenue from tuition fees. Neither of these motives ought to be criticized, provided always that the cooperative plan does not serve as a disguise for insufficient facilities, for an inadequate and overworked teaching staff, and for low educational standards generally. It is to be feared that this has been the case in some instances and that much of the real merit of the cooperative system, when pursued under the proper circumstances, may be lost sight of because of the manner in which it is sometimes conducted."

There are no exceptions to be taken to any of the statements in that paragraph except perhaps an implied one, which should not be used as an argument against the cooperative system. There are many in this audience who can think of colleges which are granting degrees on the all-resident basis which are far from meeting the requirements of what we think ought to be met in a first-class college. We will always have such educational institutions and we will have them in the resident courses and we will have them in the cooperative courses. Therefore, they ought not to be considered as an argument against either one.

Just one other point in closing; on page fifty-one of the report, we have this statement: "The attributes of the cooperative plan in developing particular personal traits and points of view together with the orientation to industrial organization which it affords, would seem to indicate that it is particularly advantageous as means of developing personnel for the administrative and operating side of industry." "This, indeed, seems to be the peculiar merit of the system which is

indicated most clearly. And it is by no means an unimportant one. The results of other studies in the general investigation of engineering education show that a large (and probably increasing) proportion of engineering graduates are entering corporate employ and sooner or later occupying positions concerned with operating duties. American industry seems to be turning more and more to the engineering colleges for recruits to man the operating side of its organizations. If, as seems likely, the cooperative plan offers even a partial solution to the problem of training men for these positions, it undoubtedly possesses merits of very great importance."

Then if you will take up the report of the Industrial Conference Board which has been printed in one of the bulletins, you will see there that engineering graduates at the end of fifteen years, are employed mostly in administrative work. In other words, two men are employed in administrative work to every one employed in technical engineering. If you put those two statements together in one, it makes quite a powerful argument.

Now I wish to say that we who are operating respect the opinion of you who are not and who do not believe in cooperative courses. We know you are perfectly conscientious in that opinion. The majority of men who are operating them are men who graduated from all-resident courses, who taught in all-resident courses and who are now operating on the cooperative basis. We believe upon the whole, that the men who are operating these courses have a pretty good view of both sides of the question. Furthermore, we want to assure you that we are not particularly interested in getting you to adopt this course. No man I know of operating cooperative courses has ever gone to another professor and suggested that that professor or that college take up the operation of cooperative courses. We have only gone when we have been asked to do so. If any of you feel at all nervous for fear that your institution might embark upon a program of cooperative education, I suggest that you invite me to come and explain it

to you, because I have done this now with four institutions and not one of them has adopted the cooperative system.

And now, most honorable Cæsar, I, who am about to die, salute you. I have one dying request to make, and that is that you adhere strictly to this program as here printed and not allow Professor Wickenden to discuss this paper of mine until these other papers have been read. By that time, I will be aboard a Boston and Maine train, enroute for a land in which the majesty of the law and its effort to save human souls does not interfere with the stomach.

W. E. Wickenden: Dean Ayer seemed to imply that the attorney for the defense should take over the case. He questions the propriety of entrusting the inquiry into the cooperative method to a detached committee and suggests that it should have been set up as an inside job. It is quite unnecessary to suggest the character of the bulletin on cooperative courses which would have been written had the task been entrusted to such eloquent advocates as Professor Timbie and Dean Ayer. In loyalty to the facts, let me point out that there was not quite such a complete dearth of interest and experience in the cooperative method among those who directed the inquiry as Dean Ayer seems to imply. The Board of Investigation and Coordination, which has given the matter considerable attention, includes among its members Dean Bishop who directs one of the schools operated on the cooperative plan and Professor Jackson, "the head of one of the most important examples of cooperative courses in the United States," as Timbie has expressed it. One of the members of the special committee which made a considerable assembly of facts which are incorporated into the bulletin was President Kolbe of the Polytechnic Institute of Brooklyn, not long since the head of the university with which Dean Ayer himself is connected. Finally, when I was a professor, in an earlier incarnation, I functioned in a capacity somewhat like that of Professor Timbie in the early stages of the cooperative work at M. I. T.

Dean Ayer was generous in stating that the facts presented

in the bulletin constitute a fair assembly. There are other facts, of course, and more yet to be assembled. Professor Timbie has made a significant contribution to the body of fact which was not available at the time the bulletin was prepared. Probably he would confess that the stimulus to gather the additional facts arose from the publication of the bulletin. The case illustrates nicely what bulletins are for—not to settle controversial matters, but to throw light on them and to stir up interest and further inquiry.

Dean Ayer questioned the logic of certain portions of the bulletin, centering his criticism almost entirely on the statements presented in parallel columns in the effort to produce a pair of contrasting composite pictures of the attitudes of those who advocate the cooperative plan and those who oppose it. They are put there in that form so that you may judge for yourself the merits of the points of controversy. It should be apparent that the editors have neither intended nor attempted to reduce the contrasted opinions of advocates and opponents to a state of logical conformity, each with the other. When all is said and done, the verdict must be given by you gentlemen of the jury and not by ex officio advocates of the cooperative plan or by an investigating staff pledged to impartiality.

MEETING OF DIVISION OF DEANS AND ADMINISTRATIVE OFFICERS AND TEACHERS OF ENGLISH.

The Joint Meeting of the Division of Deans and Administrative Officers and Teachers of English convened at ten o'clock in Aubert Hall, University of Maine, Orono, Maine, June 27, 1927, Professor J. Raleigh Nelson, University of Michigan, presiding.

Chairman Nelson: As some of you know, this is the sixth joint meeting held by the Division of Deans and the Committee on English. The Committee on English has come to regard these occasions as very important to the development of their policies and their ideas regarding the place of English in the engineering schools. We have come to depend very largely upon the results of these conferences to direct our policies and methods of procedure.

On the basis of the preceding five conferences, it seems to me we may assume that a number of points have been talked out fully enough, so that they are points of agreement.

In the first place, the importance of English in the training of engineering students and as part of their educational experience seems to be a matter of general agreement among both the deans and the teachers in other subjects in the engineering school.

There is also a growing appreciation, I think, that the tool value of English is not all, that its humanistic value is of equal, if not of greater, importance as justifying its place in the curriculum.

There is in the third place a growing emphasis on the courses in the appreciation of English literature as a means of developing habits of intelligent reading.

There has come to be an appreciation of the common responsibility of all members of the faculty in correcting the student's use of English and developing in him a real taste and general enthusiasm for good books.

These are things which, of course, are not all as yet fully accomplished, in the engineering school, but in the discussions which have preceded this, these points have been talked out quite fully. It seemed to the Committee, therefore, that, particularly in the light of the report of the Board of Investigation and Coordination, which is just being brought under discussion, it might present a somewhat more delicate subject for consideration. The report which is to be discussed at this convention has made it evident that English is regarded in the opinion of engineering educators generally as holding second place only to mathematics and physics. This is a challenge, I am sure, to everyone of us engaged in teaching English at the present time in schools of technology or engineering, but you will readily appreciate that the group of teachers who have so identified themselves with the cause of engineering education is on the whole rather limited and that the responsibility of carrying this challenge and sounding it to the teachers in the arts colleges, young teachers especially who are looking forward to careers of teaching, weighs rather heavily upon the Committee on English in this Society. As Deans you will realize, however, that only in so far as we are successful in attracting new teachers to this field of endeavor, will it be possible to meet the demand for more and better teaching of English in the engineering schools. These reasons, have seemed to justify bringing forward for discussion this question of the teacher of English in the engineering college. Where are we to get the supply of teachers who are to meet this demand?

Unfortunately, perhaps (you may not all realize this) the attitude of the teachers of English themselves outside the engineering colleges is not at all sympathetic, not at all favorable, to the opportunities which are evidently about to develop in this field.

In the first place, there is a large amount of ignorance as to the challenging opportunity which this work affords. I have been rather surprised in talking with members of our own School of Education to find there was almost complete ignorance on the part of many of this investigation, a large research

in a field in which they were not familiar. If you talk to English teachers generally in arts colleges, you will find they are not cognizant of the opportunity this work affords.

Secondly, they are ignorantly pessimistic regarding the capacity of engineering students and their attitude toward English.

In the third place there is a certain skepticism on the part of the teachers regarding the genuineness of the professed interest of the deans regarding English in the curriculum. They question whether the deans are actually willing to spend time and money to provide properly for this work. I am not expressing my own personal opinion in this matter because that has not been my experience.

In the fourth place, they have a fear of being ostracized by their associates in the arts colleges, if they do commit themselves to a field that is so apparently practical, utilitarian, possibly even commercial in its objectives.

In the fifth place, they often fear to jeopardize their opportunities for professional advancement by going into a college that is somewhat remote, in its general ideals, from the field in which they have worked.

Finally, I think some of them honestly fear that they would be limiting themselves very much in their own personal development by teaching for interminable years drill courses in freshman composition unrelieved by courses in the interpretation of literature and that by this process they would find themselves in a course of years reduced to mere task masters. That is not a prospect inspiring to young teachers.

For all these reasons, those of us who have had the opportunity of coming in touch with teachers who are considering new fields of work have found it difficult sometimes to convince them that they should come into this field. Members of our Committee are called upon constantly to recommend men for positions on the staff of your English departments. We find it increasingly difficult to recruit our ranks. Those of us who went into the field ten or fifteen years ago have enjoyed adventuring and pioneering. It has been very exciting and interesting. There is a great deal of zest still about

the entire process. We can't however, always, by process of contagion, give that same enthusiasm and interest to the young teachers seriously considering their careers.

The situation, then, is one which gives the Committee on English concern because to a certain extent it is our responsibility to help recruit the forces of English in engineering and technical schools. I think it will also concern the deans since the development of this work will depend largely upon the character of the teacher.

For this reason, I have ventured to suggest this subject which is a delicate one for a number of reasons. I do not wish anyone to feel I am staging a strike of English teachers, or am attempting to express dissatisfaction of the way in which we have personally been treated, those of us working in this field for some years. Neither do I wish in any way to reflect upon the teachers of English generally, indicating that their motives are too mercenary of calculating or that they are not willing to throw themselves into a field with enthusiasm until they are convinced it is practical for them.

I have put in your hands a list of questions for discussion.

1. What special qualifications should a teacher have who wishes to succeed in teaching English to engineering students?
2. Is there any one attribute that might be regarded as of paramount importance?
3. What opportunities for educational service are afforded in this special field at present?
4. What inducements can be offered that will make such teaching more attractive than similar work in an arts college?
5. How can information regarding this increasing demand of the engineering colleges be disseminated among the teachers of English generally?
6. Is it true, as many claim, that at present a teacher of English who goes into a technical school ostracises himself from his associates in the arts college and jeopardizes his opportunities for advancement? If so, why is this the case? How can such a situation be changed?
7. Are students in English as generally under men of professorial rank as in other subjects?
8. How do the salaries paid the teachers of English compare with those paid teachers of other subjects?

9. How generally are the teachers of English voting members of the engineering faculty and how generally are they represented on the standing committee or other governing board.

10. Is there work regarded as an integral part of the engineering course?

11. Are they assured favorable working conditions?

To these I should like to add the following: Are the deans generally disposed to increase the amount of English required or to allow more latitude for the students in their elections of courses in English, so that there will be a larger amount of elective work developing in connection with the English courses?

Are teachers who go into this field likely to have opportunities for teaching English literature or courses in appreciation of English literature as well as courses in English composition?

Professor Worfell (Bucknell College): Is not the difficulty that too many graduate students in arts or in literature are being sent to the English Departments in the engineering schools in order to keep expenses down under the delusion that anybody can teach English? I have had experience with three institutions which do that. Is not it true that these engineering teachers of English should be recruited from those schools? Our own college has a happy method of gaining teachers. The professor chooses either from our own student body or from another student body men who will make good instructors or assistants. After they have been tested for two, three, or four years, the college sends these men to graduate schools and gives them usually a stipend of a thousand dollars a year while they are there to pay expenses, with the understanding it is to be returned to Bucknell if he himself does not come back. In this manner, we have built up a rather young faculty but a strong faculty because practically every young man there has had at least two years of graduate work and half of that at the expense of the University. Ultimately each one of these men will obtain a Ph.D. but will have gained it under the guidance of the University. If the deans of the engineering schools could see the wisdom of

training their own men for this work, I am sure it would result in advantage both to the man and to the University.

Dean Potter (Purdue): Speaking for an institution which is mainly an engineering college, our own experience in connection with English may be of interest to those assembled here. Seven years ago, English was anything but popular. We had one year of required English but had very few elective courses. At the present time, all of our engineering students are required to take two full years of English and I am certain two-thirds of our students are electing at least one additional course. This is due to the fact that Professor Craig, the head of the English Department and the members of the staff have had the proper attitude. The first year Craig came, over twenty per cent of his students failed in English. The students knew it was a serious matter.

In answer to question 8, regarding salaries, the salaries of the teachers in English at Purdue are on the same scale as the salaries of the teachers of civil engineering or electrical engineering.

In answer to question 9, they are voting members. They have fully as large a percentage of representation as the mathematics or physics have.

In answer to question 11, they are absolutely assured of favorable working conditions. As an example of this, one of our professors of English became interested in phonetics. He had no way of publishing the results of his investigations; we published the results of his work at Purdue. As a matter of fact, his work has resulted in adding a great deal of interest to the study of communication on the part of the electrical staff of our institution.

In answer to question 12, I am certain most of the deans with whom I am acquainted are favorable to developing courses in English literature. You cannot teach a student English or any other language by limiting him to rhetoric and composition. He must be acquainted with the literature. We are making it compulsory for the student to take one course in English literature.

Dean Hughes (Harvard): I realize this problem is a peculi-

arly difficult one in many, possibly in all, institutions. Conditions in a University where there is a large engineering department entirely self-contained are quite different from that in another large university where the engineering school as well as certain other schools depend upon a general faculty for all of the subjects which we might call general, such as physics, mathematics, English history, and the like.

The situation at Harvard is peculiarly difficult. We all realize that our engineering students are not getting as much training in English as they should. I think one of the great difficulties is that the able teachers of English do not want to teach English composition and they will not teach it any longer than they have to.

For example, we have for all undergraduates, in both the engineering school and the college, which are the only two undergraduate departments in the university, a large freshman English course. It is unwieldy. The students themselves are of such varied training—good, bad and indifferent, and they come from such different kinds of homes—that the course is probably the most difficult and the most unsatisfactory of any course in the whole university. So largely is this true that last year the faculty of arts and sciences which controls the college voted that a student who passed a comprehensive English examination with the grade of 70 should not be required to take freshman English. I do not think myself that that is enough. In the engineering school we were not satisfied with this arrangement and required everybody who passed with 70 or better to take an additional English course in comparative literature or English literature. A great many of our engineering students take courses in English literature.

I do not know what the solution is going to be with us. I have almost come to the conclusion that a long period of routine instruction in English composition is not going to be very effective; for the boy who wants to learn English, it is advantageous; for the boy who regards it as a chore, it is a chore. I have been wondering whether anybody here has had any experience in the matter of what might be called

tutorial instruction in English. I should like to see an engineering student kept at his English writing even if it took him four years until somebody competent should say that he can write or speak decently. Has anybody ever tried it? You know at present that we have tutors in all departments in the college under whom the men work in their special subjects.

I would like to say a word or two about this matter of professors. As far as the salaries at Harvard are concerned, a man's salary is the same for his rank in whatever department he is working. A great many years ago when the scientific school, predecessor of the present school, was in existence we tried to have special professors in mathematics and the result was very far from satisfactory. We had some excellent teachers and some of the work was done admirably but the difficulty was that we could not get and keep teachers in mathematics. It was the same thing in the English course. These men soon found, when it came to the time for promotion to assistant professorships that they were at a disadvantage. The mathematics department said, "We did not appoint you; you are appointed at the request of the Lawrence Scientific School. We are not responsible for your promotion." When it came to professorships, it was practically impossible to get them appointed at all. In one exceptional case, the mathematics department utterly washed its hands of the whole situation and the man was not promoted except to an associate professorship.

As far as special instruction in mechanics is concerned, we take care of that by having mechanics courses offered in the college and taught by our own professors. I do not believe, from our own experience, that having a separate department in a subject that is known to belong to the college will work satisfactorily because I don't think the men will get promotion.

Chairman Nelson: I do not think that is true everywhere. In my own college it has not been the case. It depends on the general attitude of the dean and other members of the

engineering faculty toward these people giving academic subjects.

Dean Hughes: We do not have any control over them. We send our boys into the classes of the college for special subjects, but to try to get special professors appointed and get fair play for them in the department in which they actually belong is utterly impossible.

Chairman Nelson: Our organization at Michigan is quite different. My professorship came to me years ago through my own college and through my own dean. I have no connection whatever with the department of English in the arts college. I have an entirely independent department and I think my men have been fairly treated; as far as I am personally concerned, I have felt nothing more could be done for me than has been done.

Dean Hughes: We are not troubled about money; we can pay for them, but we can not get and keep men who are willing to devote themselves to this work. I am radically opposed to general subjects being taught in a special way. I think it is better to have the engineers study their history in the college and the same with economics. I know you do not agree with me but I believe this very strongly. If we could get the right kind of courses, the problem would be solved. The real trouble is that first grade teachers of English do not want to teach English composition.

Miss Sada A. Harbarger: What is the "right kind of course, the right kind of English course?"

Dean Hughes: Any one that is correctly taught. Any course well taught is a good course. I will say in confidence, that one of the difficulties is that most of the students are in charge of men who are studying for a doctor's degree or some other degree and they are not really interested.

Chairman Nelson: I should not, as chairman, engage in this discussion but I have a great many things I should like to say. It seems to me one difficulty with the situation that you have outlined is that the principle of classification has not been applied sufficiently to those freshman students in the composition courses. You speak of their being a heterogene-

ous group. It is almost impossible to teach such a group effectively, I think the general policy of classifying the freshman students, whether you segregate them in a college by themselves or not, classifying them according to their interests so that you can motivate their work, would be very helpful if applied here. I have a very queer feeling to be offering a criticism of conditions as they exist at Harvard. Coming from the Mid-West, I was warned that I should be careful and tactful in what I said. But I offer that, Dean Hughes, as a suggestion.

I know at least that with our own students we are carrying that principle of classification still further. It is the plan of our new President to work out a system of classification of freshman which shall arrange them in sectors: Here for example will be a group of students especially interested in writing poetry, and there a group that will be taken by a man who loves to teach young people to write verse. With an enthusiasm that is genuine, he sets himself to cooperate with the young people to do the thing they want to do. Our work with engineering students has been an experiment in group teaching on a large scale, covering a period of twenty-seven years; we have some assurance of our results.

I do think there is one principle that can be applied in a variety of ways with great effect. If the freshmen are classified and grouped according to their interest, those interests properly recognized may be utilized and turned into useful ways. If a man has himself any sort of teaching ability, enthusiasm, magnetism, he ought to be able to get young people to write about the things they are enthusiastic about themselves. That is just my suggestion for correcting the heterogenous character of the freshman sections.

Regarding the other point, that no teachers like to teach composition; I think any who have taught composition realize why a future of interminable correction of papers would not be an attractive prospect. The difficulty can be met by humane and considerate planning. In planning for the ten men under my own direction, I make my programs so that just as rapidly as a man shows ability he is allowed to teach

courses in appreciation. I give him, in addition to the work in composition, one course in literature. In this way a man ordinarily teaches ten hours, eight hours of composition and two hours of literature until he gets farther up in the staff, when, of course, his work is more largely in the appreciation of literature.

Dean Hughes: Do you think that unless a student has had a good background he will ever learn to write English? Don't you think you can teach him for years and years and not get anywhere?

Chairman Nelson: Unquestionably. That is one of the most serious problems, particularly in the Middle West, where our students come to us often without much background. I think we ought however ourselves to believe that if a man wants to write, has something to write about, he can master his difficulties and can overcome the limitations which have been imposed upon him by his parents and his home. Certainly one of the serious difficulties in such cases is getting rid of the man's inferiority complex and inspiring him with confidence. It takes sometimes four years to do this, but if one can get it into a man's mind that he can write, he can.

Professor Seavey (Tufts College): I am going to ask myself the question, what is a good course in composition. A good course in composition is one that makes contact with the experience of the student. If you can in your course of composition make contact with the experience of the student, if you can find the things he likes to talk about outside, you will find he is willing to write about those things. He finds after a bit he is writing ineffectively about those things and he wants to write better. That necessitates something deans are sometimes not willing to pay for, that is, individual conference.

At Tufts we segregate the civils from the mechanicals and electricals. In the old days, they used to be in one group. Those studying the liberal arts, those going into law were all together. They were taught one thing and it was aimed at the middle average. This is all right for the lawyers and A.B.'s but if I am talking to a group of men who expect to

be civil engineers, and I can say, "As civil engineers, you will need this," I can count on more nearly a one-hundred-per-cent response. Almost every fellow before he has entered school has some experiences in which he is still interested. If I give him a paper on how to black boots, he is not going to be wildly enthusiastic about that, but if he has worked on a tug boat in Boston Harbor and I get him to work up some of his experiences on tug boats in Boston Harbor, he is going to come in and say, "How is that, Prof?" When I get that question, I have him on his way. His interest in English is beginning to bud.

The second half year, I throw a challenge. I tell them "Instead of a final examination, I am going to have you pass in a paper that will represent your best work on some subject in which you are already interested. You have from February to June to do that." Those papers come in from nine thousand to twenty-two thousand words in length. I had those papers at Illinois with me. I threw them down before some deans in my dormitory room. One good dean said, "You can't tell me you can get students interested in doing that amount of work." I am talking now before a great many of my faculty who have seen the results.

I said, "Who teaches your English? Have you a red-blooded man?"

He said, "No, we have a red-headed woman who is interested in the pay envelope."

The reason we have not found teachers of composition for technical students is that we have not combed the field sufficiently. When I am selecting an instructor I show him all that is coming to him. I say, "Do you want to work with men or are you only working for a doctor's degree, in order to prepare to teach literature?" Some of them have fallen by the wayside and become doctors of philosophy, but I have two men at the present time, one available this year and one next year, who are men of tremendous enthusiasm for the work. Let me tell you people who have not taught English to engineering students, there is no more delightful experience than converting the men who come in hating English

into fellows who ask, "Prof, what English course do you think I had better take next year?"

We have not combed the field sufficiently. We take men from agencies who think they want to teach English. When we ask them why, they say, "Oh, I am interested in the subject of English." What they are interested in is tracing down words in Anglo-Saxon. If they are interested in men, young men, and handling the personal problems of the young men and moulding those young men, they will make good teachers of English composition in engineering schools. There are plenty of them if you can find them. I am out combing the field for them now. I have trained twenty-three of them, seventeen still in the work. One has gone to be editor, one is in the ministry and one is head of an English Department. There will be some backsliding but we can do the work.

Dean Hughes: May I ask who reads these long papers?

Professor Seavey: I promise my men we will read every single word they write. We keep our promise and they know it. When a paper is a particularly good one, I give them a special letter of commendation. I take that paper around and make the president look it over or look over the drawings anyway. They put in hours on the drawings. I force him to do it because the results of the poor work of students are shown to the dean and I think the results of the good work should be shown to the president.

Professor Chandler (University of North Dakota): It seems to me there are two troubles in the English work as I have observed it for thirty years. From the faculty point of view, the trouble is that the average instructor does not like to teach freshman work only; he would like to have advanced work. That is the inevitable. With the heavy requirements in technical subjects, engineering students have so little time to do any elective work in subjects that at first glance seem to have no connection with the other courses. If they were going to be particularly interested in language, they would have entered some other college than the engineering college. To meet this difficulty, it is important not to trust the freshman wholly to the inexperienced, half-hearted beginning teachers.

The head of our English department is on leave but the acting head of the department is practically in charge of English for our engineers, so that he is an integral part of the department.

As regards students, there is one thing I found will get them quite interested in advanced work; that is public speaking or debate. Some of them go into that work with a great deal of interest, and if the instructor is on to his job, he will give them the opportunity to choose subjects for their themes or debates. Two engineering students are often pitted against each other on some semi-technical subject. They will be the representatives of certain water works, or they will argue before the City Council or attempt to convince the voters that their particular firm is the one that can do the best work. Those boys get a great deal of interest from finding the best way to present their arguments so that they will be effective and convincing and get results. They realize this is just the kind of training they are going to need in future years. If they ever get to be chief engineers or consultant engineers, they must be able to present their subjects in a way that any ordinary person, whether engineer, highbrow, or ordinary voter can understand. You will find that a great many engineering students are glad to elect that kind of English. The instructors read the outlines, the syllabi of debate, not for the purpose of seeing if they are technically correct, but if they are presented in convincing form.

The point of view of the students in the school with which I have been connected has been changed in the past three decades. Instead of feeling that English is one of the nuisances that the faculty require, that there is no use in it, the better students are seeing the advantage of it and are glad to elect it as one of their courses. It is the better ones and not these of lower grade who elect to take English.

Professor Seavey: I have a rather unusual circumstance to add. After all the grades were in, I told my freshmen English class about this meeting and asked if they were satisfied with their course and if they were to send me down here. They paid the expenses.

Chairman Nelson: There is one point that Professor Wor-

fel suggested and Professor Chandler referred to that I cannot let pass. It has to do with the type of man who should be chosen to teach English. I do not agree with you that men from the engineering colleges, engineering graduates, should be used for this purpose unless they have gone definitely into the study of English—English literature or rhetoric.

The teaching of our engineering students is a difficult task that demands unusual qualifications. You need to get men who have a very broad, thorough training in the field in which they are working. I more and more am hunting for men who have fine backgrounds and who have a great deal to give to their students besides the drill in the mechanics of writing. I have on my staff the finest man on the English staff of the University of Michigan in imparting in a fundamental way enthusiasm and appreciation for fine literature. He is a man of forty-two or forty-three, very diffident, but a thorough scholar, a man who is recognized and respected by everybody at Michigan as a very able man. I am trying to get more and more men of that type. I think it is rather dangerous to take men from the engineering school who have not a large background in the field in which they are working.

There is one other point that needs emphasis, that is, the development of the work in public speaking in the engineering colleges. In my own work I have been for a number of years developing that so that now I have an able man who is giving a good deal of his attention to work of that sort. Everyone of our freshmen takes a two-hour course in public speaking with us. It is not a course in oratory; it is a course in which he is taught to get up and present his ideas from a preconceived plan he has made, subject to criticism and correction. This is followed by three or four other courses; one a senior course in which our students get training under an able man in the presentation of arguments along the lines in which they will have to work after graduation.

Professor D. C. Jackson (University of Louisville): As a representative of one of the youngest engineering colleges in existence, I thought perhaps it might interest the gentlemen here to know what we are doing. We have only one professor

of English as yet. He is definitely on the Engineering faculty, and he does not teach any class of the liberal arts students. He is a voting member of the faculty and serves on standing committees and functions as one of the faculty, as do the teachers in physics and chemistry, who are also as much members of the engineering faculty as the engineering teachers themselves. This professor of English has frequent conferences with the students in English, which is one of the important things he stresses.

I had the good fortune to go to Harvard before I went to Massachusetts Institute of Technology. Although I am an ardent alumnus of Harvard, although I worked under able men in Harvard both in English and mathematics, I know I did not do as good work in Harvard in English and mathematics as I might have done because they failed to get my personal interest. I liked the men personally, liked the work, but I could not see the connection between what they were giving me and my life work. I think that is one aspect of the situation Dean Hughes doesn't realize. I had the good fortune to have some courses under Dean Hughes. The courses I had with him were very interesting. One of the livest courses I had in fact was under him because I was interested. I was not interested in the work of some of the other men because they did not understand my point of view and Dean Hughes did.

With regard to public speaking, we have no separate public speaking courses. Our professor of English has frequent reports, both during the freshman and the sophomore years which have to be presented orally before the class, not read; the students do not even have notes with them. They have to know the subject. We require in all departments in mechanical and electrical engineering, three terms in English. One term is in literature. The other two terms bear more or less upon their use of English in their thesis work and outside engineering reports. Here they are applying the principles they learned the other two years.

The plans of the Dean, as far as I know them, are to secure for the men of the English faculty salaries that are compara-

ble with those of the engineering teachers. They have the students taking English under men of as high professorial rank as in engineering.

Professor Disque (Drexel Institute): I think all of the difficulties implied or expressed in these points refer to the experiences of the large universities. Speaking for a small technical institution, I think it is possible for me to answer every one of these questions favorably, for the very good reason that the small technical institutes are not hampered by the idea that has become common in the large institutions, largely imported from Germany, that the subject is everything and the student is nothing. It seems to me that that accounts to a large extent for the lack of interest among the teachers of English in the large institutions in the problem of teaching professional and technical men. I think I can go farther than that and say that in my judgment this thing has gone so far in the large institutions that the very future of the thing that we call liberal culture is in the hands of the technical institution. I mean the technical colleges, and the technical departments of the large universities, for the reason that the universities, permeated as they are so thoroughly with what has come to be called the university spirit, have lost to a larger extent their interest in the student. Of course, as Dean Hughes of Harvard has suggested, there is something to be said for a man who takes that point of view, because his promotion to a large extent depends upon things other than his ability to teach. In the small institutions and the consciously technical institutions, it seems to me that it is different.

With us, the professor of English is as much a member of the faculty as anybody else. His salary is as high as that of the engineering heads. He does all of his own theme reading. His method is exactly like that which the Professor at Tufts has described. He has done it for years because he has liked it and becaused it is recognized as his job and not as a side issue. It seems to me to a large extent the difficulties that are being experienced by engineering colleges in the teaching of English are due to the fact that in institutions the

work of the English Department is merely a sort of service from that department to a college in which they are not vitally interested.

Dean Hughes: I think that is not at all true in Harvard College. I do not believe there is a small institution in the country where the individual is made more of than in Harvard under the present system. Every man in the freshman year has a tutor who follows his work, guides his reading, takes charge of him from the time he leaves his freshman year. I think that is true of Princeton, too.

Professor Ellis (University of Maine): I should like to emphasize, if I may, the value of realizing the amount of time necessary to put into individual conferences. I think our great opportunities are in the personal conference. I am not convinced that there should be one class for civil engineers or mechanical engineers and so on. I think the opportunities there are largely through the meeting of the instructor with a student who has interest in one profession or another. We have made much use of the personal conference at Maine although there has been a reluctance to admit that the amount of time a person puts in in individual conference with the student is quite as valuable as the time he might put in in laboratory or class work. Those conferences if they are made worthwhile should be long and intensive and take a great deal out of a man. The importance must not be underestimated in considering the teacher's value or the value of this teaching.

Chairman Nelson: In my own department, when I hire a man I make it clear to the dean that I expect this man to teach ten hours a week and I require him as part of his load to put in eight hours in his office each week in personal conference with his students. I imagine a good many of them put in more, but the minimum limit of their conference work is eight hours a week. That means that every man teaching freshmen must see each student personally once in two weeks and older students for longer periods.

Dean Streubel (Brooklyn Polytechnic): Do the professors read the papers in advance and then discuss them with the

student or do they read them with the student at the conference?

Chairman Nelson: Different men have different methods. Some of the men work out material beforehand with their students, helping them plan the thing they are trying to do. Sometimes with the freshman who is a blank and who never became interested in anything, you have to spend time making an appraisal of his interest and arousing in him some reaction. Again, a student who has difficulty with the mechanics of composition, frequently has the hour spent in drilling him on some one point. The individual teacher determines what is best. Sometimes a man is largely interested in books. The hour is spent talking books with him. There is simply nothing that compares with it. I sometimes feel we could do away with the classwork altogether, if we could put in all our time in personal conferences. No one who has not done it knows how taxing it is, much more so than equal time in the classroom. Meeting a human soul and human mind whose problem you have never studied before, takes a great deal of tact and energy. The Deans should count that as one of the important things to reckon on when they estimate the amount of time which an English teacher should give to his work.

Professor Ellis: I should say the ideal method would be to have one conference cover a theme which has already been corrected in advance. There is tremendous gain in going over a piece of paper not marked up in advance and getting the student to think he is making the corrections himself. Later in the year, I think, if possible the conferences should be as personal as possible, not so much based on the work itself but suggesting new lines for the student to strike out on for himself.

Chairman Nelson: Dean Hughes, I think you will see that personal contact work is as near as one can come to the tutorial system. We have not as yet, in our midwestern colleges any facilities for providing any such means of personal direction as you have at Harvard. I know with the group of men in my own department, this method of personal con-

ference takes the place of what might be more efficient if it could be carried out.

Dean Hughes: I agree. It is done in the engineering courses in our own department.

Dean Streubel: We have in our own institution this practice. Any member of the engineering staff who has any report work from the students at all who finds the English not satisfactory, although the student has passed freshman and sophomore classes, may recommend that this man take additional work. In that way, we hold a check on the students and in many cases even in the senior year we send the student back for additional drill. It works very well.

Dean Hughes: It does not work with us at all.

Dean Streubel: We also have a play outlet for those who are interested in the drama and are anxious to take part. The boys build their own stage, do their own lighting and electrical work, and bring into play some of the practical and theoretical courses in conjunction with the English. Then, too, the inspection trips are attended by the English professor and in that way the English professors get an opportunity to observe actual engineering practice and learn what it is all about, at least what the students are writing about.

Chairman Nelson: That is perfectly splendid. I do not know what I should have done if I had not been allowed to go on some of the inspection trips. It means everything to a man who comes into a professional field with no knowledge of engineering. I had taught in the arts college for fourteen years when I took up this work. It is everything to have the engineering men receive the professor in that way and give him the assistance he needs to have in order to get the student's point of view.

Professor Disque: I am not familiar with the conditions in Harvard, never having been there. I have not the slightest doubt but that the system is as good as in the small institution as far as personal contact is concerned, but I do have reference to one or two of the things that Dean Hughes himself has said about the difficulty of enlisting the interest of the

teacher in this job and getting the better men in the English departments to devote themselves not only now but in the future to this work. It seems to me that the problem must be (I know it was so in the large institution with which I was formerly connected) much more acute than in the small institution.

Dean Greene (Princeton): At Princeton, we have all the students who take the English work together in the freshman year. This work is required of the engineers although it is not required of the A.B. and B.S. students. We have practically all of our English faculty teaching freshmen. The head of the English Department, the professor who gives graduate courses in Chaucer, the other one who cares for poetry are all interested in the freshman English and teach with a great deal of enthusiasm. We have no men who are working for a degree in that department. The men are all professors, assistant professors and instructors, and I think most all of the instructors have done graduate work in English.

The freshman course is not intended primarily as a composition course but a course to develop the appreciation of English literature. We have added a course in the senior year which is oral and written English. The men prepare reports, deliver them and learn something of that oral English which is necessary for every engineer. As far as I know, we have had no complaints from our boys in the engineering school regarding the course in English. Many of them elect further courses in English.

Professor Jackson: There is one practice at Louisville that might interest the teachers of English. Regular laboratory reports are read by the English professor first from the point of view of English, then by whomever has the course from the engineering point of view. The student gets two grades on them. That is part of his regular work in English. This practice is continued for a sophomore course in mechanical engineering so that they have two terms of that sort of thing. It is surprising to see in electrical engineering the difference in the reports that come in. I had to limit the

length of their reports because they were getting too tremendous.

Chairman Nelson: At Michigan we tried a somewhat similar plan. At the beginning of the semester, I assigned a man to be responsible for the reports and work with the students. He appeared at the beginning of the semester in the lecture room, explained the general form the reports might take, and also gave the students assignments of time when they could meet him in the office. Through the semester, as these men prepared the reports, they had the privilege of consulting him. It worked out well because it made the professor in Ch. E. 4 and the professor in English work side by side; it did not merely bring the report to the English instructor for editing. We tried out various schemes of this kind.

Dean Evans (University of Colorado): For a good many years at the University of Colorado, the work in English for engineering students has been under a separate department from the general English work in the University. This department has an entirely separate organization. It is under the control of the Engineering College. The faculty members are appointed on recommendation of the Dean of Engineering. The men do not report to the College of Liberal Arts at all. I will say in this regard that these men are treated in exactly the same way as any other members of the engineering faculty, both as to salary and general working conditions. The work has been very much more satisfactory under this plan than it was in other days when the engineering students took their English with the Art students. We are well pleased with the plan. We use the method suggested by Professor Jackson; i.e., many of the papers written for the engineering department are reviewed by the department of English, to check and grade from the English viewpoint. I believe that has helped the general training in English for the engineering student. The work is distributed through the different years of the curriculum, composition in the freshman year and literature and technical writing later with some debating as elected. We wish to put in more work

in English as electives and I think that will be accomplished as we make some changes in the course suggested by our Committee of this Society.

It seems to me in this discussion we have not stayed close enough to the main point, that is, what shall we do to get the right kind of teachers of English for engineering students. I do not know that we can solve that problem here at all. I have it in mind because we need one or two for next year and they are not easy to find. Professor Birk is the head of our department and has done an excellent job. He is the type of man we want, the man interested in teaching English to engineering students. If we can get more who are willing to go ahead with enthusiasm for this work as a life job, then we can make teaching of English to engineers much more successful than it has been in the past. We need men who see the opportunities and advantages of teaching English to engineering students. I should like to hear discussed here what methods can be used to bring before those men who are studying English in general English departments the opportunities that now present themselves in the technical schools. If that can be properly emphasized I believe our task will be much easier in securing teachers in this field. I believe we all agree that in every line of engineering instruction, the teacher is the source of inspiration for the students. That is what we want to emphasize in our search for teachers.

The Society has attempted to carry on something of a recruiting bureau for teachers in engineering lines. I wonder if we cannot have something of that sort in English? It is one of the most important subjects we have in the engineering curriculum. We want to emphasize it.

Professor Seavey: To answer that question, if every teacher of English composition who is successful in any college in the country where they have a school of liberal arts would comb his senior class each year to find the man he thinks best suited for that kind of work, interview that man over and over again and let him know what the nature of that

work is, I think we would have our recruiting bureau well established. I think that is the only way.

I just want to add a word of comment on the discussion. See the change in sentiment since the meeting at Illinois that this meeting shows and how this movement under Chairman Nelson's direction has grown in that time. The problems that faced us then were convincing administrators that there was such a thing as English.

Professor Pearson: It seems to me a great deal has been said about the practical work the teacher of English can do, how he can cooperate with men in other departments and so on, and very little about the great cultural opportunity that he has with those students. If the teacher of English is not going to give those men a wider outlook on life, who is going to do it? Is not that ninety-five per cent of his job and the composition five per cent? Have we not been talking about the five per cent all this time? As long as it is assumed that this job is to teach composition, how are you going to get men to go into it for a career?

Chairman Nelson: That is one point I had in mind. You have to make the thing appear to be really big enough to make a man want to give his life to it. It means more than teaching the mechanics of expression.

Professor Clark (University of Arizona): I have been extremely interested in this discussion this morning, in fact, the study of English has always been a hobby with me. I am gratified to see the Society assigning to that kind of study the place that belongs to it.

My interest in English developed under the finest teacher that I ever knew in any line of work. I want to put her name on record at this time because I think she is entitled to it and other students with me in my class at the time would subscribe, I think, to my statement. Her name was Miss Elizabeth MacLean, formerly at Iowa State College. Those with me in that class would say "amen" to the statement that she was the best teacher the college had at the time. What was the secret of her teaching? I would say it can be summed up in a few words: She was a real human being.

She had immense enthusiasm for the study of English but also an immense enthusiasm for the problems of all of the young men in the class. There wasn't a man who felt she did not have a direct personal interest in his affairs. It is hard to define personality I know, but it seems to me the problem of selecting a teacher of English centers around finding one with immense enthusiasm. The problem of arousing interest in English among engineering students is certainly not an easy one and it cannot be done by the average teacher of English. It requires exceptional teachers and such teachers must be paid more than the usual salary to induce them to come into the work and stay with it, but it is very much worthwhile. I would put it above a great deal of the engineering technology now taught. We do not find very much enthusiasm among engineering administrators toward the idea of lengthening engineering courses. Therefore, we must be careful as to what we do with the time allotted to the study of English. I feel that you will find it extremely difficult if not quite impossible to assign much time to the study of English literature. I feel that all the time that we have should be given to the study of English composition, if we cannot instill culture into the minds and hearts of students through actual creative work, such as we ought to be able to accomplish through English composition, I feel there is no hope for them.

I have just come from the summer convention of the Society of Electrical Engineers at Detroit. I was seething within for an opportunity to express myself on the subject of English. Finally it came. I felt like the man who has a pet story to tell and who has a hard time to hitch it on to some thing to make it seem to fit in. Finally, however, I found my opportunity. The subject of research in colleges came up, then the subject of creating some enthusiasm for research among electrical engineering students, and then my opportunity came. I jumped right up and went to it. Mr. R. E. Hellman of the Westinghouse Company had just expressed the thought that he found that among young men who came with the company whom he had had a chance to

study and analyze, almost none had any enthusiasm for the subject of research. There were almost none, he said, who desired to go into electrical design.

Since one of my hobbies is electrical design, I grasped this opportunity to point out that I felt that it was a great mistake on the part of electrical engineering teachers to have so largely eliminated courses in electrical design. Further opportunity came when I pointed out what seems to me to be the tendency to stimulate creative work which should prove the salvation of all modern education. Teachers in art and design discovered this some few years ago. Previously they had been teaching their students to copy famous things in arts. Teachers in English must have gone through the same process feeling there were desirable models which could be copied. The more modern idea is not to copy but to create. I feel there is no student, however dumb he may seem, who has not something in his head about which he can write. With a little tactful conference it seems to me the teacher in English could help him express it.

I was glad to hear the last speaker's remark about the cultural values of English. Why should not the engineers have all the advantages that the students in the liberal arts college have? They should study under the finest teachers and be subjected to the most elevating, inspiring influences in English instruction. If there is time for it, a little study of English literature would not hurt, but all the emphasis should be put on English composition. It is the main job and the one that should be done first.

Numerous speakers have referred to the point that the able teachers of English do not want to teach English composition. I made a note of that and put a row of exclamation points after it. I cannot understand the psychology of a teacher of English, no matter how able he is regarded as being, who does not want to teach composition. It seems to me that is his great opportunity. The man who wants to teach English composition has the finest opportunity in the world. I almost envy him his opportunity to teach young students to create. I cannot understand it, except for the fact that un-

due emphasis is doubtless put upon some of the abstruse researches in little by-ways in English leading to the degree of Ph.D.

In conclusion, I want to say that we have tremendous difficulty in these days in arousing interest in students in any subject. There are so many kinds of outside activity.

Professor Mayer (Tufts College): Mr. Chairman, I do not know whether I should speak or not because I am an outsider in some respects. I am one of those backsliders; I am a Ph.D. I slid out of the engineering, not even into English. Some of the things that have been said here this morning have impressed me very much since I have been constantly thinking in terms of scientific education. I am one of those who believe that a good deal of our liberal arts is still a hangover from the Middle Ages. The more we get away from the hangover and into a technical foundation for learning, the nearer we get to a better type of education above the high school grade. It seems to me in respect to English (and this is my own personal reaction) that there are two things that we must bear in mind. One is that composition, as far as engineering education is concerned, is essentially a staff function, in the engineering school. Secondly, that another phase of English, the appreciation of English that we get largely through literature, poetry, and so on, is part of that liberalizing element in education, technical education, which should be considered more or less as a line part of engineering. The staff function of composition could be carried on as it is carried on in some institutions not in the classroom but in correcting or looking over the reports of engineers that they make in their various technical courses. Certainly plenty of composition can be taught in looking over these reports and bringing to the students' attention the errors in grammar, rhetoric, etc., that they make and that they should overcome.

It seems to me that the Princeton method (as far as I have been able to judge from the talks this morning) is the most excellent method, giving the engineering freshman course in literature and not in composition. The composition should continue through the four years and the English teacher

should be called in to look over and guide the student from the standpoint of his writing. Then, if possible, in the junior and senior years, as Dean Hughes pointed out, they should come back again to fundamentals, to the tools of the trade of writing and speaking so that when they are graduated, they will have gone over certain things which they had pointed out to them the whole four years. I know I had that experience. I took engineering and as I got toward my senior year I began to want to take composition and rhetoric. I did not want it in my freshman year. When I began to realize the need in my writing (the little writing I had to do then) I found I wanted a better knowledge of the tools of writing, composition and rhetoric. Then I would have welcomed a course which was not given along that very line in the engineering school.

It seems to me there are these two different sides to your English problem; one is your composition which can be carried along as a staff function, and the other is appreciation of English which is part of the liberalizing education which we ought not to overlook or subordinate.

Chairman Nelson: For the benefit of those who were not present last June, let me say that at the conference a year ago we devoted ourselves to that matter of the development of courses in English literature in engineering colleges. That, the Committee regards as one of the most important things in the years to come in planning its work.

Miss Sada A. Harbarger (Ohio State University): May an English teacher speak? I call your attention to the fact that some members of the Committee have written for the JOURNAL at times some specifications for teachers of English. I believe one of these is to be found in the 1921 number. In selecting people and training them as members of the staff to teach English to engineers, there are three or four specifications which I think might be emphasized.

First of all, the general background in English. It seems to me we have to have teachers with special and technical training in their subject followed by some general teaching experience That is our aim at Ohio State, to take only teachers who have had some general teaching experience. On that

basis, you see, it is not an untried teacher learning first of all how to teach, but one who is in a position to develop an enthusiasm for teaching.

To that we like to have added some outside experience, whether it is in engineering or in business or what not, so that the English teacher keeps a balance between the highly theoretical side of his subject and the things that should be common to all people and enjoyed by all people.

I suppose that finally, an enthusiasm for his subject and for the work and the interests of his students. Those are just a few of the points to be kept in mind in selecting teachers.

Professor Dickinson (University of Vermont): I think this is an impossible ideal to meet with the money at our disposal. The only way we can meet this situation of securing proper teachers of English for engineers is to get two or three people to do together what the specification calls for. I talked a little while ago with the Professor of English of Brown University and I asked him why he wasn't willing to take a freshman class in English. He said, "The correction of papers is deadening. I went through that a great many years and I am not going back to it again." I think that is the difficulty we have in getting our best men to teach elementary English. That correction of papers is deadening. I don't see how any man is willing to do that all his life. I wouldn't do it myself. Much of the routine work can be handled by others just as well. If you have a team of two or three men to give the inspiration and instruction and temporary men hired for a few years at a time to do the routine work, I think then you solve the problem, but I do not believe it can be done by one individual, year after year.

Professor Seavey: I want to say one word. My assistant professor and I live in the same house, a duplex house with a tunnel in the cellar. Many times we meet going through the tunnel when he is coming through to show me something he has found in the papers or vice-versa. We like the papers.

Chairman Nelson: I think I will also take issue with the previous speaker. I have been thirty-two years teaching and that is a long time. I have been twenty years at Michigan

and I am still reading papers; and I read everything that my boys write. I have only seniors. I have read one hundred and fifty reports this last semester and I have read them carefully and faithfully. While my eyes are weary at times and my head aches, I still see back of the paper the student who tries to express himself. I do not find it a burden and I do not find it tedious.

Professor Greene: Some of us have to mark them on thermodynamics and put the red pencil on although we could get instructors to do that. It is tiresome, yes, but it is also helpful and we know how to go to the class and correct their faults after reading the papers.

Chairman Nelson: When I reach the point where I have to let somebody else read my papers, I am going to quit. Reading the paper is like the diagnosis of the physician. It is my opportunity to diagnose the particular case.

Before closing—and, although I am reluctant to bring this interesting discussion to an end, I want to be prompt—I would like to state the situation as it appears to the Chairman of this Committee. If the Committee on English is to recruit the present ranks of teachers on English and certainly if it is to develop a professional group adequate to give the engineering college the amount and quality of English work that is demanded, it must be sure of its administrative backing.

1. Such prospective teachers must be shown that this is an inspiring opportunity for educational service.

2. They must be made to realize that their students will be just as intelligent and appreciative as any group of young people of similar age and background, and that their common interests and objectives, and their rather more serious attitude toward their work, make it easier to adjust one's methods of teaching to their needs with assurance of satisfactory results, than in less homogenous groups.

3. They must be assured that every encouragement will be given them for self-development; that they will not only be given opportunity for graduate study or individual research, but that they will be expected to show themselves productive in the field of their choice; that their work will consist of courses in appreciation of literature as well as in composition,

and that the tool value of their subject, while important, is not less so than its humanistic value.

4. They must understand that they will take their places on the engineering faculty on equal footing with other members of that faculty. They will be expected to keep themselves informed regarding the trend of engineering education, and regarding developments in the engineering profession itself, and as members of the faculty to cooperate actively on committees, or in other ways, for the interest of their college. In return for their whole-hearted committment of their interests to this field of education, they should be guaranteed recognition in rank and in salary as their service warrants.

5. Favorable working conditions are often a greater inducement to a young teacher than the remote prospect of large remuneration. The teaching load should be made with full appreciation of the strain of the paper reading. Small sections should make possible work with individuals rather than mere mass teaching. Office arrangement should be made sufficient for conference work with students, which should be an integral and indispensible part of the system of teaching. Finally an intelligent, sympathetic attitude of the entire engineering faculty toward the work in English and a willingness to cooperate actively in developing in the students habits of decent usage and intelligent reading and a genuine enthusiasm for good books.

I would suggest that this meeting authorize the Chairman of the Committee in English to draw up some statement indicating that this influential organization of deans and administrators does pledge some such assurance to those to whom our Committee shall appeal for recruits.

Professor Greene: I would like to move you, sir, that the Committee on English prepare a statement for publication along the lines which you have suggested and that that statement of the Committee bear the approval of this meeting of Deans and Administrators, to follow the general form outlined.

The motion was seconded. The motion was put to a vote and carried unanimously by a rising vote. The meeting adjourned at twelve o'clock.

WHAT THE COLLEGE HAS DONE FOR THE ENGINEERING GRADUATE.*

By R. E. DOHERTY,

Consulting Engineer, General Electric Company.

I have gradually become involved in the educational work of the large industrial organization with which I now have the honor to be associated; and thus, what started as a diversion from my engineering work has now become one of my major undertakings. This work, which includes the supervision of the post-graduate training which our organization conducts, has afforded an opportunity to study the attainments of large numbers of engineering graduates from many different institutions, and has given me some facts and impressions which have a bearing upon the efficacy of engineering education, and which it is my purpose this evening to present and interpret.

May I further preface my remarks with respect to my view of the general situation regarding engineering education? I am not one who thinks, as some do, that college programs are all wrong; neither do I think that the industrial programs with respect to young men are all they should be. Both have points of great merit, yet both have room for improvement. The engineering college affords a fair measure of cultural background. It broadens the point of view, and, above all, engenders a profound and exclusive respect for facts and a desire to interpret them—an attitude of mind which has been both the bed rock and the inspiration of human progress. The great achievements of engineering graduates can not be overlooked in any thoughtful and purposeful review of those phases of engineering education in which much improvement is yet to be made. Likewise, a similar parallel may be drawn with respect to the programs which the electrical industries

* An address delivered before the Cornell Session of the S. P. E. E. Summer School for Engineering Teachers, July 25, 1927.

have arranged, for taking up the graduate where the college leaves off. As I view the situation, the engineering colleges have made remarkable progress during the century of their existence, particularly when one considers the rapid industrial evolution during that period—not merely an evolution of the material side, but especially, as we consider it here, an evolution of the industrial ideas of what a college graduate should be. So while the colleges have not been able to keep pace with this industrial will-o'-the-wisp, it should nevertheless be recognized, in any present appraisal of progress, that they have at least made an earnest attempt to do so.

With these thoughts in mind, I shall now outline my conception of what the present day engineering graduate has attained from his college course, presenting first some facts and impressions which may interest you, and then attempting to interpret them with one or two recommendations.

In forming an estimate of such attainments, a number of sources of information have been available. I have observed engineering graduates at work, and have had expression from others who have critically watched them in action. This has indicated clearly that they show superior resourcefulness and initiative alongside men of the same age, of greater practical experience, but without college training.

Another source of valuable information is the college record. This includes a transcript of all college grades, and, to the greatest possible extent, the extra-curricular activities and the ratings by professors. This gives a good indication of the man as a student, and it shows that the large majority of the 400 or 500 graduates who come to our organization each year, have been good students; and this point should be kept in mind in evaluating their attainments.

Perhaps the facts which will be most interesting to you are the results of examinations which were given to the student engineers in the Testing Department—i.e., men in their first year after graduation. When the Advanced Course in Engineering was organized in 1923 by our Company, 72 out of a total of about 400, student engineers applied for admission to the course. An entrance examination, which is only one of

a number of factors which determine the selection, was given to these applicants. The results were so interesting and significant that it was decided to give a similar examination to as many of the others as were available—namely 275, making a total of about 350 who took the examination. Considering the probability that the best students were in the group which tried out for the Advanced Course,—the average grade being highest for this group—the results of the several sections were consistent, and the same general conclusion could be drawn from all—namely, that in matters which we regard as of great importance, their proficiency and knowledge, on the whole, fell far short of a reasonable expectation. A working knowledge of such fundamental principles as Conservation of Energy, Laws of Motion, and those relating to Electricity and Magnetism, and also a working technique in the simpler forms of algebraic and trigonometric relations, are surely attainments which, with the ability to reason, are requisites for any young man who expects to follow *professional electrical engineering*. It was in these matters that a very poor showing was made.

The examination was framed with two main purposes in mind; one, to indicate the degree of acquired technique in the simpler forms of mathematics, and in the art of handling standard methods of solution as applied to typical forms of problems—that is, those processes which require little more than the application of a good, orderly memory; and secondly, to indicate originality and capability in reasoning from fundamental principles, and in correlating a number of simple, but interdependent, phenomena. With these two points in mind, a number of sets of questions were prepared, of which the following is typical:

1*A*. A direct current generator and a drum 2 ft. in diameter are mounted on the same shaft. The rope from this drum passes over 2 pulleys, one 18 inches and the other 14 inches in diameter. A weight W of 100 lb. is hung on the end of the rope. The flywheel (WR^2) of the generator and drum is 200 lb. ft.^{2} At the start, the weight is 50 ft. above

the ground and is allowed to fall, thereby speeding up the generator.

(*a*) What is the velocity of the weight at the instant before it strikes the ground?

(*b*) What is the acceleration of the weight at this instant?

(*c*) What is the acceleration at a point 25 ft. above ground?

(*d*) What is the power delivered by the rope to the rotating parts connected to the generator shaft at the instant (*a*)?

1*B*. The generator in problem 1*A* is loaded on a water box 2 ft. long, 2 ft. wide and filled with water to a height of 2 ft. The switch between the generator and water box is open while the weight is falling, but as it strikes the ground the switch is closed. A constant field is maintained on the generator so that the voltage is proportional to speed and is equal to 20 volts at 100 r.p.m. The resistance of the water box is 4 ohms.

(*a*) What is the deceleration of the generator immediately after the switch is closed?

(*b*) Neglecting losses in the generator and leads, what will be the average temperature rise of the water when the generator has come to rest?

2. Derive the formula for the solution of the general quadratic equation:

$$ax^2 + bx + c = 0.$$

3. In a proposed road bed of a railroad there is an angle *AOB* of 141.5°. It is required to construct a curve with a radius of curvature of 3000 ft. between the lines *AO* and *OB*. Find the distance from *O* to the points of tangency, *C* and *D*.

4. A constant 60 cycle, A.C. voltage of $e = 110$ volts is applied across a circuit consisting of resistances $R_1 + R_2$, and inductances, $L_1 + L_2$, all connected in series; as shown in the figure. If $R_1 = 8$ ohms, $R_2 = 12$ ohms, $L_1 = .015$ henrys, $L_2 = .01$ henrys, what is the voltage (*a*) between *A* and *C*?; (*b*) between *B* and *E*?; (*c*) between *C* and *E*? For each of these voltages (1) give the magnitude; (2) express the voltage as a vector; (3) draw the vector diagram.

INFORMATION ACCOMPANYING QUESTIONS.

Angular velocity ω in radians per sec. $= 2\pi \times$ rev. per sec.
Moment of inertia

$$I = \frac{WR^2}{g}.$$

$$\text{Mass} = \frac{W}{g}.$$

Kinetic energy of rotating mass is

$$E = \tfrac{1}{2} I\omega^2.$$

Power, $P =$ rate of doing work, that is rate of change of energy. That is, $P = dE/dt$.

Peripheral velocity v in feet per second $= r\omega$ where r is in feet, ω in rad. per sec.

Acceleration is:

$$\text{linear } a = \frac{dv}{dt},$$

$$\text{angular } \alpha = \frac{d\omega}{dt}.$$

1 B.t.u. $=$ 778 ft. lb.,
1 B.t.u. will raise 1 lb. water 1° Fahrenheit.

Accelerating Torque is:

$T = Ia$; $I =$ moment of inertia,
$a =$ angular acceleration.

Accelerating Force is:

$F = Ma$; $M =$ mass,
$a =$ Linear acceleration.

The time allowed for the examination was 4½ hours.

Now as to the results for this particular group of 72 applicants for the Advanced Course: In the first problem relating to dynamics and the transfer of kinetic energy to heat,

73 per cent failed, 27 per cent obtained correct answers—this in spite of the fact that, after much questioning by the students, *the energy equation was finally written out for them.* In the second, which was the solution of the simple quadratic —*i.e.*, high school algebra—17 per cent failed, 83 per cent set down correct answers; but about half of the latter could not solve it even after the suggestion was given that they "complete the square." They merely set down the answer from memory. In the case of the third problem, which involved geometry and trigonometry, 12 per cent failed and 88 per cent solved it. In the fourth, relating to a simple electric circuit, 34 per cent failed, 66 per cent solved it.

Consider the character of the errors. As in any examination involving problems, careless mistakes in numbers and in algebraic transformations played their usual part, 26 per cent of the errors in *all* problems falling in this class. An additional 30 per cent of all the errors occurred as a result of weakness in the elements of mechanics. In the first problem, out of the 72 students, 8 assumed all of the potential energy of the weight to be delivered to the rotor; 4 calculated the temperature rise of the water by dividing B.T.U. by cu. ft.; 8 confused work and power; 7 could not handle vector equations; 3 took mass equal to pounds weight; and 3 added vectors arithmetically. Many merely omitted the questions: 4 omitted the 1st part of problem 1, and 8 omitted the 2d part; 5 omitted problem 2; none omitted 3; and 3 omitted the 4th.

As to the grades received, the maximum (given to 5 students) was 100, the minimum 25, and the average 74. For the group comprising the other 275 students, the maximum was 100 (given to 2), the minimum 0 (given to 14) and the average grade was 29, indicating, as already mentioned, a lower proficiency than among those interested in advanced engineering work. But a significant portion of that difference must be attributed to help which was given to the first group but not to the second. Incidentally it may be worth mentioning as an indication of the value of the examination, that the average grade for those selected students (25 in number) who completed the first year of the Advanced Course was

89.5, while for those who started the course but failed to complete it, (5 in number) the grade was 72.6.

You may be interested to know that the falling-weight problem, with certain modifications, has been given each year in the entrance examination for the Advanced Course; likewise, the quadratic. Not much improvement has been indicated. Of the first section of 53 students taking the examination in last year's group, *i.e.*, 1926 graduates, only 18.9 per cent solved the first part of the falling-weight problem, 5.7 per cent the second part. A poorer showing than in the first year, but it is only fair to add that no help was given, as it was in the first year. The amount of help given has been reduced during the four years since 1923, to a minimum, which fact is reflected in the average grades for these years, which are 74.3, 61.4, 49.4, 39.6. In this last year, 32 per cent used "g" incorrectly; 19 per cent confused energy and power; 26 per cent assumed that the total potential energy in the weight was delivered to rotor; 64 per cent made miscellaneous mistakes in units, constants, etc. In the case of the algebra problem, 26 per cent failed, one third of whom made no attempt at a solution. So much for the examination.

Still another source of information is the class room performance of the selected few who are admitted to the advanced Course in Engineering. In this connection I think it is both fair and essential to state that this group is representative of the best students in the country. Their college records, the comparative results of the entrance examination already referred to, and the record of achievement of the graduates of the course, all testify to this. The thing which has impressed me most deeply in studying these boys in the first year class room is, with rare but notable exceptions, an attitude of helplessness when faced with a problem requiring original synthesis—a habit of thought which requires, in the solution of problems, the memory of a detailed precedent in order for it to function. The typical mind among them is not trained to reason from basic principles or to visualize the phenomena it may attempt to relate.

Their method of attack is interesting and indicative. If,

for instance, a problem is given relating to Dynamics, such as the falling-weight problem already referred to, their first step is, not to consider what fundamental principle determines the conditions which must be satisfied, and thus establish the working relations; rather they proceed to write down on the board every formula they can remember which may involve velocity, acceleration, kinetic energy, etc., not, mind you, because these relations may apply in the given case, for often they do not, but because those formulae comprise their full equipment acquired in college for the solution of problems falling under the general heading of Dynamics. So it would be also if the general heading, for instance, were Thermodynamics. Then, without a thought of the controlling principles involved, they try to obtain some solution merely by algebraic manipulation of these expressions. This method of attack, I say, is interesting, and seems to indicate clearly a practically complete lack of training in deductive reasoning.

On the other hand, if the problem be of a different character, requiring inductive process, one may expect a reasonable solution. As I suggested in my opening remarks, the interpretation of facts and the profound respect for them are habitual and very desirable characteristics which I have observed in these students.

May I also record the threadbare observation that students are, on the whole, distressingly low in their ability to present their ideas, clearly and convincingly, either in written or verbal form? Indeed, it is often not alone a deficiency in knowledge and practice of the principles of Rhetoric, but of Grammar also. The least I can say about this is that, in view of the great importance of clear expression in engineering matters, it is a most deplorable fact.

I shall now sum up the impressions, which I have acquired through the foregoing sources, of the typical electrical engineering graduate, representative, let us say, of the first quarter of the classes graduating from college. He has profound respect for facts; he can interpret them rationally; he possesses a prodigious stock of miscellaneous engineering knowledge, rules and precedents, and he can manipulate ac-

cording to those rules and precedents. But he bears a most burdensome handicap, so far as concerns the practice of professional engineering, as distinguished from the rule-and-handbook variety, and that is an undeveloped ability to reason deductively. He is lost when thrown into a field where he does not have a formula for the specific case, yet where he knows and can recite the laws which determine completely the results he is seeking. It may not occur to him, in his search for a formula, that any law applies; but he knows the law. The point is, he does not know how to use it. His mind functions by rule, and not by reason. It can carry on, but not create. It is formal and hide-bound. He has the further handicap of being unable to express his thoughts clearly. In a word, he is trained to manipulate according to rule and precedent; he can reason inductively, but not deductively; and he can not effectively convey his ideas.

This is my concept—and it is clear cut in my mind—of the typical engineering graduate from the upper quarter of the graduating group; and it leaves me, of course, with a somewhat definite negative view regarding the efficacy of college programs with respect to their developing those precious qualities which a number of men naturally possess in a significant degree, and which are so sorely needed in engineering today. It may be answered that the programs are not efficacious in this respect because the objective has been in a different direction—namely, to develop large numbers of engineers capable of carrying on mass engineering work along established lines, and also capable of the maximum possible productive effort at the time of graduation, leaving it to chance that the occasional genius may survive the program. If so, the object is accomplished; and there is no question that in years past, Industry demanded that kind of graduates, and many industries, if I am correctly informed, still demand it. And it is true that large numbers of such men are now needed in the industries. But, considering the ever increasing complexity of the art, the dizzy rate of progress into new electrical applications, and the consequent need for pioneering minds to steer and stabilize that progress, I think we should

all agree that the undeveloped qualities which I have mentioned should not be overlooked.

How, then, may the situation be improved? I have no panacea. I recognize and appreciate the many practical difficulties which are encountered when one attempts to frame a program to accomplish the objects I have mentioned. Any program must gear in with the complicated educational structure, as now evolved, with all its ramifications, economic and political, and with staffs trained largely in the philosophy under which that structure was reared. The problem can be solved only by guiding and accelerating that evolution, which has long been under way, by unrelenting pressure, constant vigilance, and a high degree of cooperation between the colleges and the industries. Thus only, in my opinion, can the traditional lag of the college program behind the changing view of industry be effectively reduced; and I trust that finally the industrial will-o'-the-wisp, which the colleges have faithfully chased for almost a century, is now taking definite and tangible form. And with the really magnificient work which the Society for the Promotion of Engineering Education, under the masterly leadership of Mr. Wickenden and his associates, has been doing in clarifying the problem and in proposing definite lines of progress—this Summer School for Engineering Teachers being one notable instance—I have great optimism regarding the future.

So, all I can do is to give you the benefit of our experience, and suggest one or two points which may be helpful to you gentlemen, in whose hands the mental development of our young men rests. The evidence is clear that most engineer-graduates do not have a working knowledge of those few important, fundamental principles on which the engineering art is based: Conservation of Energy, Newton's Laws of Motion, Kirchoff's Laws and others relating to Electricity and Magnetism, Boyle-Charles Law, Laws of Thermodynamics, Hydrostatics and Hydrodynamics, Law of Heat Flow, Theory of Superposition, its application and limitations, Potential Fields as related to Gravitational, Electric, Magnetic Fields and to Mechanical Stress, and their graphical representation, etc. Since so many are thus deficient, I strongly urge that an ex-

amination be given to the entering junior class, testing them with reference to a *working knowledge* of such of these fundamentals as they may have had up to that time. This would show up the points of weakness. And in my opinion these should be cleaned up, even if it took the whole first semester to do it. I submit that a student is not prepared to proceed in engineering studies without that foundation. As it is, Mathematics, Mechanics, Thermodynamics, etc., as well as Economics, are given as separate and largely unrelated subjects, and when once the theoretical study is completed, they are set aside, and the student then takes up engineering subjects with almost no further reference to them.

This leads to an obvious further suggestion. The only way to learn to use these principles in engineering—if I may say so without its appearing to be platitudinous—is merely to use them. To learn a group of formulae, based on such principles, but with the connection torn away, is not learning to *use the principles.* And without this, one can be only a handbook engineer. My suggestion is that the engineering work of the last two years be *interwoven* with the use of these fundamental laws, and that many of the problems be of a nature that will require reasoning directly from them. Also the problems should be of a nature requiring a consideration and correlation of more than one phenomenon. For instance, how many electric circuits in actual practice can be considered as comprising merely x, r and z without reference to such interdependent phenomena as mechanical forces, strain, motion, heat-flow and heat storage, etc.? Not many. Why then should students be taught to think categorically as most of them are? I think that such a plan would make the work more interesting, that it is practicable in the present circumstances, and that it would be efficacious.

To make sure that I shall not be misunderstood, I wish to refer further to the latter suggestion—namely, that engineering studies and problems of the last two years be so arranged that students would be required, under sustained repetitions, to refer to these principles, to reason from them, and to correlate a number of interdependent phenomena involving electricity, magnetism, forces, masses, motion, heat,

etc. Please do not understand that I am urging additional burden on the student. On the contrary, it is my conviction that the present programs are already overloaded. Centuries of college experience have determined that 125 to 130 semester-hours is about the limiting load a student can carry and, at the same time, obtain from extra-curricular activities those precious benefits which prepare one to deal and associate with human beings. But what do engineering colleges, with less than a century of existence, do about it? They require, on the average,* 149 semester-hours, ranging from a maximum of 183 to a minimum of 111 (next above being 124). In my opinion, this additional load is deadly to the engineering profession in two respects: it dulls the imagination and cramps the horizon of students who pass through it; and, what is even more serious, it drives from the profession many capable, energetic and ambitious young men who naturally belong in engineering work. Could we not, at least, for the leaders in the class, eliminate special courses, shop work, and much of the routine laboratory reports, and thus create free hours for thoughtful reading and association with fellow students? I therefore hope I have made it clear that in the foregoing suggestions, I am not proposing additional work.

While there are many other points I should like to discuss in these connections, and also with reference to the methods we have adopted in guiding the post-graduate training of student engineers, and of the general program for the selection and advancement of young men—I am nevertheless obliged to forego this in the interest of emphasizing the suggestions which I have offered.

In closing, I wish again to express to you not only my own personal interest in these matters, but also the interest of the Company with which I am associated; and I hope that you will feel free to call upon us for any service which we may be in position to render toward the satisfactory solution of this mutual problem of training and placing young engineers where they may grow to the fullest and most effective development of their natural powers.

* Data from the JOURNAL OF ENGINEERING EDUCATION, Jan., 1927, pp. 488, 490. Average of 78 engineering colleges.

A BRIEF HISTORY OF THE UNIVERSITY OF NORTH CAROLINA.

BY GEORGE M. McKIE,

Professor of Public Speaking.

North Carolinians have lately been poking more or less gentle fun at themselves for falling into the habit of boasting about North Carolina's "firsts." There is one "first," however, that no North Carolinian, native or adopted, would care to see ridiculed. That the infant state in its first civic utterance should have accomplished the ambitious word *university* is a beginning that all North Carolina is proud of. Such an auspicious fact cannot be laughed off—so ambitious was its hope and so concrete has been its realization.

Provided for in the constitution of the State, adopted in 1776, the birth year of the Republic, chartered in 1789, the corner stone of the first building, Old East, laid in 1793, and formally opening for the doing of its job in 1795, the University thus testified to the concern of the founders of the State that "all useful learning" should be "encouraged and promoted."

Did Hinton James, the first student, entering the University in February, 1795—did Hinton James, as the wheels of the wagon that brought him bumped along through deep sand and red clay mudholes—did Hinton James (may I ask again?) yearn for the "useful learning" that would one hundred and thirty-two years later replace the sandy and muddy roads with a system of hard surfaced highways? Whatever Hinton James thought of the roads or whatever he yearned for, he took the first steps on the way that led to North Carolina's physical upbuilding. He became a civil engineer, and some of his works for deepening the channel of the Cape Fear still stood a few years ago. So North Carolina began early to know her engineers.

The history of the University "befo' de wah" was the pleas-

ant history of the feudal South. Young gentlemen from all the southern states thronged its halls. Lovely ladies enhanced every public occasion with their beauty and charm; and, may I add, the policy of limited coeducation, which has brought women into closer and more constant contact with the University, has not lessened their power to contribute beauty and charm to the campus scene. Some of the young bloods owned their own saddle-horses, prophetic perhaps of the automobile nuisance of the modern campus. There were duels, even. A rock in Battle's Park bears the name of Dromgoole's Tomb, and its red stains are said to be from drops of Dromgoole's blood. Cynical scientists will try of course to spoil the thrill of those who come upon the rock in moonlight strolls by calling the stains oxide of iron, but romance will not down so easily—so Dromgoole's blood and tomb.

During the Civil War the University struggled along with most of its students and many of its faculty in the Confederate army. Five years after the war, weakened by dissension and lack of support, it closed its doors. Five years later, in 1875, owing largely to the boundless faith and untiring labors of Mrs. Cornelia Spencer, the University again took up its work. A pretty tradition has it that Davie Poplar lost its leaves when the University closed in 1870 and remained apparently dead until the reopening in 1875, when it again leaved out. The old tree is alive to-day.

A summer Normal School, probably the first in the United States to be established in connection with a college or a university, was begun in 1877. After continuing for many years as a normal school, it was made a regular quarter in the University year with most of its courses carrying University credit.

Although a state university, the University of North Carolina had served the State for many years before it received direct support from the State. During the early years the support was mainly from gifts, escheats, and the sale of Indian lands. An interesting incident that vividly lights up the struggles of the University after its reopening took place

in 1876. Johns Hopkins University with an endowment of $3,500,000 was in process of formation. A committee was sent to Chapel Hill. Dr. Gildersleeve, a member of the committee, asked President Battle what the income of the University was. "Seven thousand, five hundred dollars from the State and tuition fees," was the reply. "I am sorry for you," remarked Dr. Gildersleeve. In 1881 the state entered upon the policy of direct financial support, though until about 1900, when North Carolina began to find herself industrially, the support was very meagre. In the first hundred years eighteen buildings had been erected, and five more had been added when, in 1905, the state gave its first building to its University. Since 1905, the number of buildings has grown from twenty-four to forty-four.

For many years the University was not a University. It was a college. In 1843 the Law School was founded. Although affiliated with the University, it was not incorporated with it until 1899. So close, however, was the affiliation and so much a part of the University body and spirit were the teachers who made the Law School that the legal incorporation was only a seal on the relation that already existed. Attempts at the foundation of a School of Medicine and a School of Pharmacy were made in 1879 and 1880. These schools were thoroughly established as organic parts of the University in 1890 and 1897 respectively. Graduates of the University had from the beginning of course gone into the profession of teaching. Courses in pedagogy had been offered for a number of years when in 1910 the School of Education was organized.

The history of the schools of Commerce, Public Welfare, and Engineering is quite like the history of the School of Education. In each case courses were offered in some department, but there was no organization into a school. Courses in economics and accounting had been given in the Department of Economics, and the School of Commerce was established in 1919. The School of Public Welfare was the natural outgrowth of interest in rural economics and sociology. This school was founded in 1920.

The School of Engineering, the youngest of the schools of the University, was organized in 1922. Before that time such courses in engineering as were offered were grouped in the School of Applied Science. The School of Engineering now, instead of being a sort of department in the School of Applied Science, includes four departments of its own. The system of Cooperative Education was put into operation with the very organization of the school. In this system is put into scientific operation the method immortalized by Dickens of spelling *horse* and then currying one.

One hundred and thirty-two years have passed since the first engineer to graduate from the University of North Carolina entered its doors. Many of the same oaks that shaded the paths that Hinton James and his fellow-students trod still remain to shelter the students of 1927, engineers as well as others; and the University, renewing its life in the contacts of its various schools, shows every sign of having entered into eternal youth.

REPORT OF AUDITOR, CARNEGIE FUND.*

June 17, 1927

MR. W. O. WILEY, *Treasurer,*

Society for the Promotion of Engineering Education

My dear Mr. Wiley: I have audited the cash account of the Society for the Promotion of Engineering Education—Carnegie Fund, and have prepared the attached statement. The cash balance on hand in the Mellon National Bank is $13,574.89, and $967.01 additional in the Director's Office should be accounted for. The total is $14,541.90.

Gifts of $22,450.00 have been received from various individuals and Companies to a special fund for the Investigation of Engineering Education. Certificates of deposit to the extent of $14,450.00 have been purchased and are in the possession of the Secretary, Dr. F. L. Bishop.

During the year 1926 the Carnegie Corporation made a gift of $10,000 to be used for publications. From September to December, 1926, the amount spent for publications was $2,895.71. From January, 1927, to this date $3,700.26 has been spent. The cash balance therefore includes $3,404.03 of this fund.

The gift of $7,500 for Summer School for Engineering Teachers has been reduced by payments of $511.67. The cash balance therefore includes $6,988.33 to be spent for this purpose.

The cancelled checks on file in the Secretary's Office have been examined in connection with the bills and found to be correct.

Cordially yours,

G. S. RUPP.

* Presented at 35th annual meeting of the Society, University of Maine, Orono, June 27–30, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION—CARNEGIE FUND.

Combined Statement of Cash Receipts and Disbursements January 1, 1927 to June 13, 1927.

BALANCE ON HAND—January 1, 1927:		
In Mellon National Bank, Pittsburgh	$18,108.62	
In Director's Office, New York City	417.02	$18,525.64
RECEIPTS:		
Contribution from Carnegie Corporation for Summer School for Engineering Teachers	$ 7,500.00	
Publications, Lantern Slides etc. sold by Director	118.96	
Interest on Daily Balances	207.70	
Subscriptions to Special Fund for Investigation of Engineering Education ($3,000 received in 1926—Total received to this date $22,450)	19,450.00	27,276.66
Total		$45,802.30
DISBURSEMENTS:		
Salaries of Director and Staff	$10,578.00	
Rent, etc.	839.55	
Expenses of Staff	479.23	
Expenses of Board	357.19	
Equipment, Office Supplies, etc.	344.50	
Total	$12,598.47	
Publications—Special Fund	3,700.26	
Expenses—Summer School for Engineering Teachers	511.67	
Certificates of Deposits—Commonwealth Trust Company of Pittsburgh	14,450.00	31,260.40
BALANCE ON HAND—June 13, 1927		$14,541.90
ANALYSIS OF CASH BALANCE:		
In Mellon National Bank, Pittsburgh, Pa.	$13,574.89	
In Director's Office, New York City	967.01	
	$14,541.90	

PROPOSED SURVEY OF LAND-GRANT COLLEGES.

Formation of a Special Advisory Committee composed of nine members on the Survey of Land-Grant Colleges of the United States, one of the largest of its character ever undertaken in the country's history, was announced at the Department of the Interior recently. The committee includes:

The Secretary of the Interior, Chairman.

The Secretary of Agriculture.

President R. A. Pearson of the University of Maryland, College Park, Maryland, representing the Association of Land-Grant Colleges and Universities.

President R. S. Wilkinson of the State Agricultural and Mechanical College, Orangeburg, South Carolina, representing the Conference of Negro Land-Grant College Presidents.

State superintendent of Public Instruction of Illinois, Francis G. Blair, Springfield, Illinois.

President L. D. Coffman of the University of Minnesota, Minneapolis, Minnesota.

President S. W. Stratton of Massachusetts Institute of Technology, Cambridge, Massachusetts.

President Charles A. Lory of the State Agricultural College of Colorado, Fort Collins, Colorado.

Miss Martha Van Rensselaer, Director of the New York State College of Home Economics, Cornell University, Ithaca, New York.

Survey of land-grant colleges was authorized by the last session of Congress at a cost of $117,000 and is being conducted by the Bureau of Education of the Interior Department. There are 69 land-grant colleges, each State and territory maintaining one for white students and 17 States operating additional colleges for colored students. The number of students enrolled in them last year amounted to approximately 327,000 of which 314,000 were white, and 13,000

colored students, and their staff comprised 23,188 professors and instructors. All of the institutions are State-supported and their total income in 1925–26 was $129,200,000, the Federal Government contributing $4,134,000.

In connection with the formation of the Special Advisory Committee, final plans for the conduct of the survey by the Bureau of Education were also made public through a statement issued by Commissioner John J. Tigert of the Bureau. It follows:

"This survey is a national study of the accomplishments, the status and future objectives of the land-grant type of education, and not a collection of surveys of individual institutions. The functions of this type of educational institution as originally established by Congress and as developed during the past three quarters of a century are public and democratic in nature. They have practical purposes which are worthy of full recognition as belonging to the field of higher education. The survey, therefore, is being conducted entirely from this point of view.

"While the Bureau is maintaining entire control of the work and is assuming full responsibility for the report as finally issued, the different groups already organized to promote the interest of special aspects of land-grant college education and the individuals who are directing and who serve on their staffs are being utilized to the fullest extent. The rank and file as well as the leaders of land-grant college education are being consulted and given an opportunity to express opinion. The personnel for the survey also is being drawn in a large part from the land-grant college group.

"All of the lines of activity and interest and the relationships of land-grant colleges are being covered by the survey. This means that the work is being organized upon functional lines. Under this procedure, specialists are being employed in each of the various fields of inquiry to complete detailed questionnaires upon their particular fields. Considerable progress has already been made in the preparation of these questionnaires, which will later be assembled, coordinated, and consolidated.

"In order to establish personal contact with the workers in land-grant colleges and to discover the matters which are to be included in the survey, and also in order to secure their recommendations with reference to personnel to assist in the survey, the chief of the Division of Higher Education of the Bureau, who is in immediate charge of the survey, has just completed visits to practically every land-grant institution in the United States. These visits have permitted personal consultation in interviews lasting from one to three hours, with more than 400 deans, directors and presidents."

The survey of the land-grant colleges is expected to cover a period of two years and a number of organizations are cooperating with the Bureau of Education in the work. The Executive Committee of the Association of Land-Grant Colleges and Universities is acting as contact between the Bureau and the Association and each section of this association has designated a committee to represent their special interest. The Department of Agriculture is cooperating and making available its stores of information and technical knowledge. The American Veterinary Association has also selected a committee to act as contact between the survey and those interested in the professional training of veterinarians. The Association of Governing Boards of State Universities and Allied Institutions has appointed a committee to furnish information with reference to methods of control and finance in land-grant colleges. Similar arrangements are expected to be made with other organizations interested.

SECTIONS AND BRANCHES.

Members of the Society for the Promotion of Engineering Education and those interested in engineering education at the *North Carolina State College of Agriculture and Engineering* met together on October 10th and organized the North Carolina State College Branch of the Society for the Promotion of Engineering Education.

Prof. J. M. Foster was appointed as temporary Chairman. He then appointed a Nominating Committee, which committee after due deliberation submitted the following list of nominations for officers of the Branch:

Prof. J. M. Foster, Chairman,
Prof. L. E. Wooten, Secretary,
Dr. T. P. Harrison, Journal Correspondent,
Prof. C. L. Mann, Chairman of Program Committee.

These officers were elected and assumed office immediately.

Professor Mann was given authority to select the members of the Program Committee.

It was decided that the Branch would hold a meeting on the third Monday of October, November, January, February, April and May, making six meetings per school year.

The sixth Annual meeting of the Ohio Section was held at the University of Akron the afternoon of May 13 and the morning of May 14. This was the first time that a two-day meeting had been tried, but it was considered, by all of the 38 people who attended, a plan worth continuing. While not so many different Ohio schools and colleges were represented at the Akron meeting as at some of the previous ones, this one was distinctive from the fact that so many of the teachers of the fundamental subjects—mathematics, English, physics, drawing, mechanics, chemistry—attended. It is evident that these instructors are aware of the problems involved in engineering education as related to their particular subject and desire to aid and cooperate.

The Chairman of the Section for the past year, Professor F. C. Caldwell, Ohio State University, presided at all the meetings. The plan was to have informal discussion directed by certain specified leaders rather than formal papers. The Friday afternoon session was concerned with the Junior College in its relation to engineering, the first years of the professional courses and sub-professional training. President G. F. Zook, University of Akron, opened the discussion. He considers the Junior College as one of the solutions of all the problems of higher education, and as an aid to the solution of the problems of engineering education. All of these problems grow out of a single factor—the increased number of people going to college. This, in turn, increases the problems of admitting, selecting and guiding. But as the increased enrollment in engineering schools has not been rapid, they have in some respects not had to face these problems in their intensity as have others. The graduate of the American school, in the opinion of President Zook, is not fitted to begin immediately any kind of professional education. The professional schools definitely decided to admit students on the basis of high school graduation; but so long as high school graduation is the basis of admission, the proportion of general cultural, and technical subjects cannot be decided. In higher education, we are responsible for aiding and abetting the movement of making a college course a four-year one, irrespective of reason. We have not provided ourselves with means and courses to draw away from the four-year course those who by ability and training should not be in a course of this length. Native ability, preparation, and individual characteristics should determine the length of formal education. The vocational education movement in the high school is firmly established, but vocational education as a whole is not touching the students as a whole, and the high school course of four years limits the opportunity for following a vocational bent. Semi-professional courses are just emerging from the purely vocational, and from the purely professional; but even with the subtraction of the semi-professional, the problem is not elim-

inated. This is the field of effort for the Junior College in the future. So far the Junior Colleges over the country offer the first two years of the Liberal Arts education; but in the future, their greatest usefulness will be in completing semi-professional training.

The general discussion which followed President Zook's remarks, centered around the need of finding some way to work out a semi-professional course that would avoid waste in educational training. Standards are not to be lowered, but courses, adapted to those who wish practical training, are to be offered. Most of those who participated in the discussion seemed to feel that some definite plan should be devised whereby engineering colleges can do something concrete and constructive for the 65 per cent who do not graduate; for elimination by failure was thought to handicap a man in any future work he might undertake in industry. It was suggested that the faculty might observe students for one year. If, at the end of the first year, the student has not shown ability to develop as an engineer, he should be shifted into a semi-professional course for an additional year. Then, a certificate given at the end of the second year would be significant, for it would indicate not failure but a practical training of a rather severe character.

No meeting was held Friday evening, but the members of the Section visited the laboratories of the Ohio Insulator Company at Barberton. Here, Mr. A. O. Austion, Chief Engineer, gave an interesting talk on some of the problems connected with insulators, and there were some spectacular demonstrations of high-voltage experiments. Saturday morning, Professor J. E. Boyd, Ohio State University—selected as one of the instructors in mechanics for the S. P. E. E. Summer School at Cornell—presented briefly an outline of the proposed schedule.

At the business session, the members present voted to rescind the action taken at the Annual Meeting in Cincinnati in 1926, to hold two meetings annually of the Ohio Section—one in the fall and the other in the spring; and to hold the

Annual Meeting at the most suitable time in May, preferably at Ohio State University because of its central location. Experience during the past year seems to have demonstrated that two meetings a year of the entire section are not practicable. By unanimous vote, it was decided that the Ohio Section extend to the S. P. E. E. members in such institutions as are contiguous an invitation to join the Ohio Section, and that the Secretary of the National Society should give the invitation to the various institutions. A new Executive Committee was instructed, by unanimous vote, also to draw up the following resolutions:

1. A resolution to reaffirm the ideals of better instruction in mathematics in the grade schools and to make use of this resolution in cooperating with the present efforts of the Mathematical Society as may seem most effective to the Committee.
2. A resolution protesting against the demoralizing effect upon high school education produced by the Bing Bill on Compulsory school attendance, and advocating such changes as may seem advisable. This resolution is to be submitted at the next Annual meeting for its consideration and action.

The officers for the year 1927–1928 are:

Chairman: F. H. Vose, Case School of Applied Science
Vice-Chairmen: James E. Boyd, Ohio State University
J. B. Brandeberry, University of Toledo
Secretary: S. A. Harbarger, Ohio State University.

S. A. HARBARGER, *Secretary.*

COLLEGE NOTES.*

University of Arizona.—The only faculty changes are the appointment of B. S. Butler, of the U. S. Geological Survey, to take the place of Dr. F. L. Ransome, who resigned, as Professor of Economic Geology. Butler is one of the best known economic geologists in the country, and is now completing a work on the Ore Deposits of Colorado, which will be similar to the one on the Ore Deposits of Utah, published several years ago, of which he was the author. He takes up his duties here at the beginning of the second semester.

Paul M. Thornburg, formerly instructor of Mechanical Engineering at the University of Minnesota, comes to us in the same capacity to take the place of M. J. Leahy, who resigned to engage in more remunerative professional work.

Dr. Wm. M. Davis, Professor Emeritus of Geology at Harvard, comes to us again during the second semester this year as Lecturer in Physiography. Dr. Davis is the foremost Physiographer in the world.

The most important piece of apparatus recently secured is a complete outfit for studying crystal structures by the use of X-rays, which is now being installed.

Case School of Applied Science.—An interesting group of 270 men, many of whom are on the upper side of 30 years, can be found working in classroom and laboratories of Case School of Applied Science three nights a week. Many nationalities are represented in this group. Industrial work being carried by these men in their daily occupations is usually a practical application of their night study.

In the Electrical Engineering classes there are 20 men, one of whom is a draftsman in Cleveland, but who has been Assistant Engineer in the Russian Navy. Others include

* Items of interest in the colleges are solicited and will be published each month under this heading.

sales engineers, battery men, research engineers of The National Carbon Company; and several from The Cleveland Electric Illuminating Company. All have industrial connections but are feeling the need of the fundamental, engineering principles.

Twenty others are studying with the Mechanical Engineering faculty. These men are machinists, tool designers and draftsmen. Eight are interested in Mechanical Drawing.

Courses offered in the Case laboratories and taught by nineteen members of the faculty are as follows: Descriptive geometry, algebra, calculus, structural design, highway engineering, physics, radio engineering, metallography, chemistry, electrical engineering and mechanical engineering.

They are enrolled in Cleveland College, which for two years has been cooperative and affiliated with Case School.

George Washington University.—The College of Engineering, which was formerly under the Department of Arts and Sciences, has been replaced by a separate School of Engineering in recent reorganization of the University. The classes formerly given in the College of Engineering have been grouped into five departments, each with an Active Chairman, as follows:

The Department of Architecture,
Professor Norris Ingersoll Crandall.

The Department of Chemical Engineering,
Professor Colin M. Mackall.

The Department of Civil Engineering,
Professor Frank A. Hitchcock.

The Department of Electrical Engineering,
Professor Norman B. Ames.

The Department of Mechanical Engineering,
Professor James J. Platt.

The 1927–28 enrollment on October 13th was as follows:

B. S. in C. E.	121
B. S. in E. E.	106
B. S. in M. E.	64
B. S. in Chem. Eng.	47
B. S. in Chemistry	35
Bachelor of Arch.	64
B. S. in Physics	9
Special	26
	472

Of this total, 136 are new students, and 336 are old students.

The University of Hawaii.—Professor Carl B. Andrews has been granted sabbatical leave for the year 1927–1928. He is at present taking advanced work at the Massachusetts Institute of Technology.

Professor J. M. Young, Professor of Structural Engineering, has been granted leave from teaching duties in order to devote time to the supervision and drafting of plans for the new Science Building for which $150,000.00 was appropriated by the last legislature.

Professor John A. Ely, Dean of Engineering at St. Johns College, Shanghai, has been granted leave from St. Johns University and is taking Professor Andrews' work during the present year.

Mr. Alfred Neuffer, who was formerly connected with McClintic Marshall Company's Philadelphia office, is an instructor in civil engineering.

Plans and specifications for the engineering units, for which $60,000.00 was appropriated at a recent session of the legislature, have been approved by the Board of Regents and construction is expected to begin about December 1st. Plans for these buildings were drawn in the Engineering Department under the supervision of Professor Andrews.

Iowa State College.—A new $56,000 Chemical Building was completed this summer which is one wing of a proposed building costing about three times the above amount. Besides housing the Chemical Engineering Department, the building will house the extensive research work conducted by the En-

gineering Experiment Station on Utilization of Agricultural Waste Products. We have under way at this time the setting-up of a considerable amount of machinery for the manufacture of building lumber substitutes from cornstalks. The U. S. Bureau of Standards is cooperating in this work.

The college has inaugurated a personnel office this fall after studying the question throughout last year. The Engineering division has established a separate office to work in co-operation with the central office and we have Prof. F. D. Paine and Instructor M. R. Good working part time on this work. As the work is just being organized we cannot report much definite progress at this time.

The Engineering enrollment this fall shows 1,300 students as compared with 1,212 on the same day a year ago.

The Engineering Division of the **Kansas State Agricultural College** has made rather outstanding progress since the war period under the direction of Dean R. A. Seaton. This progress may be classified under three heads, namely enrollment, faculty and equipment.

In 1920, the enrollment of the Engineering Division was 550 while last year this figure had grown to 1,019, or an increase of 73 per cent. According to a survey made by Professor C. E. Sherman of Ohio State University of 15 leading engineering colleges and universities of the Middle West, this is the largest growth of any included in that list. Kansas is becoming more and more industrialized which, no doubt, has been a factor in increasing the demands on her engineering colleges.

The engineering faculty totals 54, representing men from 18 different engineering schools of the country. Nearly one third have master's or professional degrees in their special lines. It has been the policy of the division to secure men from the outstanding engineering schools, feeling that greater strength is obtained by that diversification. Promotion from the ranks to advanced positions has been found to be the best policy when consistent with safe progress of the various departments. This lends encouragement to greater effort on

the part of the younger men and also serves to preserve balance of policies.

In the past year relatively few changes have taken place in the faculty. In the Agricultural Engineering Department, Assistant Professor V. R. Hillman resigned to go to West Virginia and Instructor Edw. Gordon from Iowa State has been added. In the Department of Architecture, T. A. Chadwick, from North Dakota, temporarily takes the place of Burr Smith, absent on leave for graduate study at Harvard. The Electrical Department suffered a great loss last year in the death of Professor C. E. Reid, head of the department. Professor R. G. Kloeffler, who has served as second man in the department since 1916, was promoted to succeed him. Professor Kloeffler came from Michigan University and has demonstrated technical and administrative qualities needed for that position. Assistant Professor R. M. Kerchner was promoted to Associate Professor and George F. Corcoran, from Minnesota University, was added to the faculty.

The Machine Design Department has found it necessary to employ three men on their staff; namely, J. C. Olsen, Colorado, in place of W. B. Hafford, resigned; Geo. T. Branigan, Nebraska, in place of John B. Hawkes, who has been made editor of Ginn & Company's engineering texts; and Earl Sitz, from Ames, in place of Associate Professor F. A. Smutz, on leave of absence on account of ill health. The Civil Engineering Department made two promotions in rank last year. Associate Professor M. W. Furr was promoted to Professor and Assistant Professor L. V. White to Associate Professor. In the Department of Applied Mechanics, Assistant Professor Benj. Spieth was promoted to Associate Professor and Assistant Professor Harold Allen also to Associate Professor. Associate Professor I. A. Wojtaszak, who was on leave of absence last year, is again on duty with this department.

By way of equipment, the Engineering Division is occupying the relatively new building completed six years ago, which is already being taxed to its utmost capacity. Some relief will be given when the new power plant now under construc-

tion is completed. This will make available the space now taken by the old heat and power units for an extension of the Mechanical Engineering laboratories, Steam and Gas and Hydraulics. The Electrical Department has added a new laboratory for the course given the freshmen in direct current machines which will also be used for the work in principles of alternating currents to be introduced for the sophomores. This will relieve the pressure in the main dynamo laboratory for upper classmen.

Should the enrollment continue its upward trend in the Engineering Division, more space for classrooms and laboratories will need to be obtained. The present plans call for a large wing connected with the present building which will include a new dynamo laboratory, agricultural engineering laboratories, as well as room for classes and research work. It is hoped that the state legislature will realize the need and make appropriations to care for the enrollment in the future.

University of Kansas.—G. C. Shaad, Professor of Electrical Engineering, has been appointed Dean of the School of Engineering and Architecture.

University of Minnesota.—Professor John R. DuPriest of the Oregon Agricultural College has entered upon his duties at Minnesota as head of the Department of Mechanical Engineering, succeeding Professor John J. Flather whose death occurred last year. Professor DuPriest graduated from Virginia Polytechnic Institute and Cornell University.

Other appointments include: Joseph A. Wise, Assistant Professor of Structural Engineering, from the Corps of Civil Engineers, United States Navy; C. A. Hughes, Assistant Professor of Structural Engineering, from the University of Toronto; I. M. Kolthoff, Professor of Analytical Chemistry, from the University of Utrecht, Netherlands; K. J. DeJuhasz, Instructor in Internal Combustion Engines, from Budapest, Hungary; Lawrence Washington, Earle D. McKay, and Vernon C. Lundquist, Instructors in Mechanical Engineering; Loyst C. Caverly and Erwin R. Summers, Instructors in Electrical Engineering; David J. Deneen, Instructor in Ar-

chitecture; William F. Ryan, Instructor in Fine Arts; S. C. Andreae and Walter G. Waterman, Instructors in Drawing and Descriptive Geometry; Leo Branovan and Edward A. Saibel, Instructors in Mathematics and Mechanics.

New construction to house the forge shop and foundry has completely filled the space between the two Mechanical Engineering buildings.

University of Missouri.—The following additions have been made to the staff of the Engineering College of the University of Missouri, for the college year 1927–28: Dr. James R. Lorah, Assistant Professor of Chemical Engineering; Mr. P. T. Rumsey, Instructor in Electrical Engineering; Mr. A. T. Raymond, Instructor in Mechanical Engineering.

Substantial gifts of equipment for the engineering departments have been received from industrial concerns. These gifts aggregate from $15,000 to $20,000 in the past three years and have materially supplemented State appropriations for equipment uses.

Plans are being formulated now for the Engineers' Convention which is held yearly during the middle of March. A number of prominent speakers drawn from engineering and public life fill out an interesting program of from one and one-half to two days. In addition, the students provide laboratory exhibitions and demonstrations for the general public and visiting guests in addition to traditional social features, including the knighting ceremonies for the Knights of St. Patrick, smoker, luncheon or banquet for guests and a dance.

The attendance in the College of Engineering has shown a slight increase during the present year over past years. The registration, October 1st was four hundred fifty-eight.

Montana State College.—Dean F. B. Norris has returned after a year's sabbatical leave of absence spent in the East. Dean Norris was located in Boston during the year and devoted part of the time to some research work for the Ordnance Department at Watertown Arsenal.

Professor E. L. Grant of the Department of Civil Engi-

neering is on a sabbatical leave for the current year and is pursuing some graduate work at Columbia University.

The engineering registration for the fall quarter is 410 as compared with 370 at the same time last year.

Mr. John Morrison has been added to the faculty of Civil Engineering as assistant in Civil Engineering.

North Carolina State College.—The most important items of the building program of the year for the School of Engineering of State College are additions to the Electrical Engineering-Physics Building. The first unit of this building, occupied last January, had been constructed to the height of two stories. The first addition is to raise the building two more stories to allow the expansion of the Departments of Electrical Engineering and Physics, and to furnish quarters for the Department of Architectural Engineering. The second addition will be a two-story wing, 60 feet by 190 feet, to house the Departments of Civil and Highway Engineering, and the Engineering Experiment Station. The Engineering Building, completed, will have cost $330,000.00.

Northeastern University.—Fifty per cent of the graduates of the Engineering School in the class of 1927 have taken permanent positions with firms with whom they did their cooperative work.

A survey of the 940 graduates of the School of Engineering shows that 73 per cent of the men are engaged in the professions for which they studied while in school, or in allied professions. 9 per cent are employed in miscellaneous occupations such as insurance, real estate, farming, preaching, and clerical work, while the occupations of 8 per cent of the graduates are unknown. Approximately 5 per cent are doing full time graduate work in other institutions; another 5 per cent are teaching, 3 per cent in high schools and secondary institutions, and 2 per cent in colleges and universities.

Oregon State Agricultural College.—Upon May 5th the Board of Regents voted to establish an Engineering Experiment Station and appointed Dean Grant A. Covell, former dean of the school, director of the Experiment Station and

dean of the Engineering Graduate School. Professor S. H. Graf, head of the Department of Mechanics and Materials, was appointed associate director of the Station. At the same time Professor H. S. Rogers, former head of the Hydraulic Engineering Department, was appointed dean of the School of Engineering and Mechanic Arts and professor of civil engineering.

Professor George B. Cox, of the University of Wisconsin, was appointed head of the Department of Industrial Arts and Engineering Shops. Mr. A. A. Boettcher, graduate of the University of Nebraska, and formerly employed by the Union Pacific Railroad, was appointed instructor in mechanical engineering. Mr. E. C. Starr, a graduate of Oregon State College, and formerly in the Research Department of the General Electric, was appointed instructor in electrical engineering. Mr. Fred Ervast, a graduate of the Oregon State College, employed in the City Engineering Department of San Diego, was appointed instructor in civil engineering.

Pratt Institute.—School of Science and Technology. Mr. Louis Porter and Mr. John A. Weishampel were added to the Faculty of the Industrial Mechanical Engineering Department at the beginning of the Fall Term in September.

Mr. Porter, a graduate of the Massachusetts Institute of Technology, Class of 1925, takes up his work here after one and a half years of drafting and experimental work with the Morgan Construction Company and Max Henkles, both of New York City.

Mr. Weishampel, a graduate of West Point, Class of 1917, and New York University, Class of 1926, has had a varied engineering and teaching experience. Mr. Weishampel was instructor in Theory and Method of Machine Gun Fire in France during the war and was later instructor in Map Making for the Pennsylvania National Guard. He has had five years engineering experience in steel mills and later was in the Research Department of the Kentucky Aircraft Corporation of Kentucky.

Syracuse University.—Professor L. N. Street is on leave of

absence for the year and Professor H. W. Blackburn, of Burlington, Vt., is taking his work. Mr. Herbert Keating, Instructor in Applied Mathematics, resigned, and Prof. Earl F. Church was appointed to fill the vacancy.

Dean Louis Mitchell has been appointed a member of the Building Code Committee to revise the present code for the City of Syracuse.

The College of Applied Science began the year with a record Freshman class of 141, of whom 21 are registered in the five-year course, which was inaugurated last year.

North Texas Agricultural College.—Beginning in September of this year we are offering two part-time courses in the Department of Engineering and Trades. A similar course is being offered by the Department of Agriculture.

A two-year course in Practical Electricity is being worked on the cooperative plan. A limited number of students picked from several hundred applicants attend classes for six weeks and then go out on the job for six weeks. The class is divided so, that one half is in class while the other is out at work. Each student has a partner with whom he alternates in the class and on the job every six weeks. The present enrollment in this the initial class in this kind of work is seventeen. These students are also being given physics, mathematics, English, and drawing.

A part-time cooperative automobile course is also being offered. This work is completed in six months, and the men alternate monthly between classroom and job. Present enrollment in this course is fourteen and new students are enrolled every thirty days, the classes running continuously.

University of Utah.—Dr. Dorsey A. Lyon, formerly Assistant Director and Supervisor of Experiment Stations U. S. Bureau of Mines, resigned in June his Washington position in order to accept of the Directorship of the Department of Mining and Metallurgical Research at the University and the Superintendency of the Intermountain Station of the U. S. Bureau of Mines, located on the University Campus. The University and the Bureau of Mines have thus consolidated

the work in Utah under the single headship of Doctor Lyon.

Associate Professor Howard L. Baldwin of the Department of Civil Engineering resigned his position in July and Thomas C. Adams of the U. S. Bureau of Public Roads was appointed to succeed him. Thomas J. Parmley, last year Instructor in Physics at Cornell University, has been appointed Assistant Professor of Physics in the University. H. E. Mendenhall, last year Instructor in Electrical Engineering in the California Institute of Technology, has become the new Assistant Professor of Electrical Engineering in the University. E. L. Quinn of the Chemistry Department, who was on leave of absence at Stanford last year, has returned to his duties at the University.

The corner stone of a new building at the University to accommodate the enlarged work of the Mining and Metallurgical Research Department was laid October 7th with suitable exercises. The Governor of the State, George H. Dern, officiated.

Last Spring all the engineering curricula were revised in order to incorporate the recommendations set forth in the "Preliminary Report of the Board of Investigation and Coordination" as published on page 5 of the Report. The revised curricula becomes effective this fall. The principal revision consisted of the introduction of a course in general economics extending throughout the year.

University of Wisconsin.—*Promotions:* Department of Chemical Engineering—*O. A. Hougen* promoted from Assistant Professor to Associate Professor of Chemical Engineering. Department of Hydraulic and Sanitary Engineering—*L. H. Kessler* promoted from Instructor to Assistant Professor. Department of Mechanics—*J. B. Kommers* promoted from Associate Professor to full Professorship. Department of Mining and Metallurgy—*E. R. Shorey* promoted from Assistant Professor to Associate Professor. Department of Steam and Gas Engineering—*D. W. Nelson* promoted from Instructor to Assistant Professor.

New Appointments: R. T. Homewood appointed as In-

structor in Hydraulics; D. H. Pletta, K. F. Wendt, and Hugh Turrittin appointed as instructors in Mechanics.

Leaves of Absence: Professor D. W. Mead of the Dept. of Hydraulic and Sanitary Engineering was absent September 21 to October 14 to serve on a Committee appointed by the United States Chamber of Commerce on an investigation of the Flood Protection of the Lower Mississippi Valley. Professor Frank Woy of the Department of Engineering Administration on leave of absence for the year 1927–28. Dean F. E. Turneaure on leave of absence from Nov. 20 to Feb. 1 for a tour to South America.

The 1927 Wisconsin legislature appropriated $577,000 for a new Mechanical Engineering building for the University. In addition to the above amount, a sum of $30,000 was appropriated for moving and setting up the present equipment in the new laboratories.

This building will be one of a new group of engineering buildings which will be located on a part of the campus permitting future extensions more readily than they can be made with the present buildings. As the new group is constructed, the old group will be turned over to other University departments.

The Mechanical Engineering building will have a gross volume of approximately 1,750,000 cubic feet, and a new floor space of 95,000 square feet. The space in the building will be divided approximately as follows:

Engineering Shops	42,000 sq. ft.
Steam and Gas Engineering Department	40,000 " "
Machine Design Department	7,000 " "
Engineering College Mechanician	6,000 " ".

The erection of this building will relieve not only the present very much overcrowded conditions of the Mechanical Engineering laboratories, but its erection will make space available for the laboratories of the Mechanics Department. The Mechanics Department will occupy the present Steam and Gas Laboratory space when the new building is completed.

Changes in Faculty: Assistant Professor L. J. Peters of the

Electrical Engineering Department has returned from a year's leave of absence during which he was engaged in researches relating to the use of electrical and physical methods in locating and mapping underground deposits and strata. Associate Professor Raymond J. Roark of the Mechanics Department has returned from a leave of absence of one semester during which, in company with Professor Bryan, he made a trip to the big game country of Eastern Africa.

A piece of cooperative research work which has just been agreed upon is that between the Steam and Gas Engineering Department and the American Society of Heating and Ventilating Engineers. The agreement is for one year, with the understanding that it will be continued indefinitely if the results are mutually satisfactory.

The purpose of the research is to study the infiltration of air through the various types of walls that are used in building construction, and to ascertain the amount of air that leaks into a building around windows and doors, both with and without weather-stripping. Such fundamental data are very much needed by engineers in the heating and ventilating profession.

The agreement provides that the American Society of Heating and Ventilating Engineers shall furnish $1,000 a year for carrying on this work. An equal amount will be provided by the College of Engineering research fund. The funds furnished by the Society may be used for fellowships, salaries of part-time assistants, or for the purchase of material or the building of test walls.

The Steam and Gas Department is very well equipped for carrying on such work, the apparatus being located in the Camp Randall shops. Tests on a numbers of types of windows have been carried on during the past two years.

A general program of tests will be developed by the Infiltration Committee of the American Society of Heating and Ventilating Engineers. The committee is composed of the following:

Professor A. C. Willard, Chairman (Head of Mechanical Engineering Department, University of Illinois),

D. Knickerbocker Boyd, Philadelphia, Penna.,
L. A. Harding, Buffalo, N. Y.,
E. B. Langenberg, St. Louis, Mo.,
W. S. Timmis, New York City,
Professor A. P. Kratz, University of Illinois.
Professor G. L. Larson, University of Wisconsin.

The actual test work will be conducted under the direction of Professor G. L. Larson.

Last spring Professor Larson was appointed a member of a committee of the American Society of Heating and Ventilating Engineers to prepare a code for Testing Building Insulation. The other members of this committee are Professor A. P. Kratz of the University of Illinois and Professor J. C. Peebles of Armour Institute. The Committee prepared a tentative code which was presented to the Society at its summer meeting in June. On September 27, 1927, this Committee held a meeting in Chicago with representatives of eight different insulation manufacturers to further discuss the code before presenting it for final adoption.

This College has, during the past three years, conducted considerable instructional work of graduate rank for practicing engineers in the city of Milwaukee. The courses given have been in the Departments of Metallurgy and Electrical Engineering. A new course will be offered during the current year on the *Theory of Radio Circuits.*

Yale University.—The first issue of the *Yale Scientific Magazine* appeared in May. It is a quarterly edited and managed by students with a Faculty Advisory Board. Scientific and engineering articles by professors and graduates present material from laboratory and field in attractive and readable form. There are also news and personal items. One department is conducted by the Yale Engineering Association (alumni), all of whom receive the magazine.

There are over forty graduate students in Civil, Mechanical and Electrical Engineering. The number in Electrical Engineering is the largest; this includes more than a dozen officers from the Army and Navy taking the course in communication.

Associate Professor Edwin H. Lockwood, well known for his experimental research work in Mechanical Engineering, has been advanced to the grade of professor.

The Northeastern District Convention of the American Institute of Electrical Engineers will be held at Yale next May.

The Yale Engineering Camp was completed in August 1926. It is situated on a tract of land three and one half miles long and three miles wide in the Town of East Lyme, Connecticut, about fifty miles from New Haven, ten miles from New London, and six miles back from Long Island Sound. The buildings comprise an instruction hall with lecture rooms, recitation rooms and drafting rooms, an instrument house, and a combined kitchen and open-air dining pavilion, all built of field stone. In addition, there are seven wooden buildings along the shore of a lake in which the students live. Each of these buildings accommodates fifteen students. The maximum number of students that can be accommodated at the camp at present is approximately one hundred, but the camp was planned to provide double that number by merely increasing the number of barracks.

Students in nearly all of the departments of engineering are required to take an elementary surveying course at the camp during a portion of one summer vacation. Students in civil engineering are required to take courses at the camp during a portion of each of three summer vacations. There are two regular sessions, one of four weeks during the early part of the summer and one of four weeks during the latter part of the summer. Between these sessions the camp is used by the Yale Forestry School. In addition to the courses usually given at an engineering camp such as surveying, railroad engineering, highway engineering and hydraulic engineering, special courses are given such as engineering drawing, to students who desire to make up or anticipate such courses. The number of students in attendance at the first session of the camp during the past summer was ninety-seven and at the second session, sixty-seven.

NEW MEMBERS.*

BERTHET, CHARLES, Instructor in Mathematics, University of Detroit, Detroit, Mich. D. P. Gilmore, T. E. Pettengill.

CARPENTER, ARTHUR H., Assistant Professor of Metallurgy, Armour Institute of Technology, Chicago, Ill. C. I. Palmer, J. C. Penn.

CAVERLEY, LOYST C., Instructor in Electrical Engineering, University of Minnesota, Minneapolis, Minn. O. M. Leland, W. E. Brooke.

CHURCH, EARL F., Assistant Professor of Applied Mathematics, Syracuse University, Syracuse, N. Y. Louis Mitchell, F. L. Bishop.

DEJUHASZ, KALMAN J., Instructor in Mechanical Engineering, University of Minnesota, Minneapolis, Minn. Fred. Bass, O. M. Leland.

DENKEN, DAVID J., Instructor in Architecture, University of Minnesota, Minneapolis, Minn. O. M. Leland, W. E. Brooke.

DISQUE, ROBERT C., Academic Dean, Drexel Institute, Philadelphia, Pa. F. E. Turneaure, C. E. Magnusson.

DOLAND, JAMES J., Assistant Professor of Sanitary Engineering, University of Illinois, Urbana, Ill. J. E. Babbitt, W. C. Huntington.

GEBHARDT, GEORGE F., Professor of Mechanical Engineering, Armour Institute of Technology, Chicago, Ill. C. I. Palmer, R. V. Perry.

GEILE, WILFRED G., Associate Professor of Building Construction, North Carolina State College, Raleigh, N. C. W. Jay Dana, C. W. Bicker.

HUGHES, CHESTER A., Assistant Professor of Structural Engineering, University of Minnesota, Minneapolis, Minn. O. M. Leland, W. E. Brooke.

HUGHES, THOMAS P., Instructor in Forging, University of Minnesota, Minneapolis, Minn. O. M. Leland, W. E. Brooke.

HUNT, ORVILLE D., Assistant Professor of Electrical Engineering, Kansas State Agricultural College, Manhattan, Kans. R. G. Kloeffler, R. M. Kerchner.

HUNTLEY, PHILIP C., Associate Professor of Experimental Engineering, Armour Institute of Technology, Chicago, Ill. C. I. Palmer, R. V. Perry.

JOHNSON, CHARLES A., Director of Engineering and Trades, North Texas Agricultural College, Arlington, Tex. H. D. McMurtray, F. C. Bolton.

KRATHWOHL, WILLIAM C., Associate Professor of Mathematics, Armour Institute of Technology, Chicago, Ill. C. I. Palmer, J. C. Penn.

LOHR, WILLIAM S., Associate Professor of Civil Engineering, Lafayette College, Easton, Pa. D. B. Prentice, W. B. Plank.

* Table showing membership by institutions will be published in the January JOURNAL.

McFARLAND, DAVID F., Acting Dean, School of Mines, The Pennsylvania State College, State College, Pa. R. L. Sackett, A. J. Wood.

McINTOSH, W. ROSCOE, Assistant Professor of Civil Engineering, University of Louisville, Louisville, Ky. B. M. Brigman, D. C. Jackson, Jr.

McKAY, EARLE D., Instructor in Mechanical Engineering, University of Minnesota, Minneapolis, Minn. Fred. Bass, O. M. Leland.

NEAL, JESSE H., Instructor in Agricultural Engineering, University of Minnesota, Minneapolis, Minn. Wm. Boss, O. M. Leland.

PEEBLES, JAMES C., Associate Professor of Mechanical Engineering, Armour Institute of Technology, Chicago, Ill. C. I. Palmer, R. V. Perry.

PENNINGTON, JOHN V., Instructor, Rice Institute, Houston, Texas. H. K. Humphrey, J. M. Pound.

RAYMOND, ALLAN T., Instructor in Engineering Drawing, University of Missouri, Columbia, Mo. F. L. Bishop, Nell McKenry.

ROMNESS, JULIUS, Instructor in Agricultural Engineering, University of Minnesota, Minneapolis, Minn. Wm. Boss, O. M. Leland.

SCHELL, FREDERIC B., JR., Instructor in Mechanical Engineering, University of Pennsylvania, Philadelphia, Pa. G. E. Crofoot, W. S. Franklin.

SCHERGER, GEORGE L., Professor of History and Political Science, Armour Institute of Technology, Chicago, Ill. C. I. Palmer, J. C. Penn.

SLOANE, ALVIN, Instructor in Engineering Drawing, University of Maine, Orono, Maine. B. C. Kent, E. J. Felker.

SNYDER, M. K., Professor, Washington State College, Pullman, Wash. F. L. Bishop, Nell McKenry.

TYLER, A. G., Assistant Professor of Agricultural Engineering, University of Minnesota, Minneapolis, Minn. Wm. Boss, O. M. Leland.

VANCE, BRUCE B., Instructor in Mathematics, University of Louisville, Louisville, Ky. B. M. Brigman, W. B. Wendt.

WHEATLEY, EDWARD A., Registrar and Secretary-Treasurer, The Association of Professional Engineers of the Province of British Columbia, 5367 Elm Street, Vancouver, B. C. W. E. Duckering, E. G. Matheson.

WISE, JOSEPH A., Assistant Professor of Structural Engineering, University of Minnesota, Minneapolis, Minn. O. M. Leland, J. I. Parcel.

Members elected since annual meeting	86
Total Individual Members, November 10, 1927	2,058
Total Institutional Members, November 10, 1927	120
Total Membership, November 10, 1927	2,178